POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 72 NEW YORK, DECEMBER 9, 1930 *Number 24*

Don't Get Excited

THESE are trying times for the business man. Orders mean more than usual. Sales effort is greater and competition strong. The temptation for salesmen to become super-aggressive to the detriment, at times, of ethical standards is urgent.

But when it is all over, the man who has carried through without violating the accepted concepts of fair dealing, good sportsmanship, commercial probity, technical integrity and gentlemanly behavior will stand better with his customers, his competitors and with himself than one who suffers himself to be diverted from the high standards to which he professes to adhere.

If he can, and perhaps because he does, succeed in confining himself and his associates to a conscientious compliance with the rules of the game he may, in his wrought-up condition, be over-keenly critical of those who have not been so happy in avoiding transgressions.

Through the mists of depression little things loom large and offenses that would ordinarily occasion no more than contemptuous disapproval are made the subjects of denunciation and angry complaint.

One dog's bark will start a dozen. A salesman who loses an order finds an alibi in some sharp practice, misrepresentation or price cutting by a competitor. Personalities are indulged in, animosities engendered, and two whole organizations spend time and nerve force in worry and mutual vituperation that had better be spent in chasing another prospect.

I do not excuse or condone the alleged offense because of the urgency of conditions. Such lapses are regrettable and usually react upon the perpetrator. I caution against magnifying their malignity by taking them too much to heart.

The stagnation will be the sooner over and will be the less serious in its effects if we keep our heads and direct our energies into corrective and helpful channels. And when it is past and the breeze of prosperity fills our sails again, we shall be in better trim and humor to go forth to new adventure if we have kept our nerves steady [illegible] provokingly stressed.

F. R. Low

EDITORIALS

What Will the Public Utilities Do?

AS A RESULT of the recent elections and subsequent political publicity, there has developed, in some directions, a sense of uncertainty and even insecurity as to the status of public utilities. From whatever position the situation may be viewed, the fair-minded must realize that the voter's dissatisfaction with the present state of public utility affairs is manifest.

The problem centers about whether there shall be federal ownership and operation of water powers, whether regulation shall be by state or federal authority and what method of valuation shall be used when fixing rates. Through all, there is an increasingly apparent feeling that the present order is about worn out and another step is imminent.

The integrity of the principles of "private initiative" and "less government in business" are in the balance. It is probable that the body politic does not want public ownership but will insist upon some revision of the present regulatory methods. One thing is certain: The utilities have a great responsibility and they will undoubtedly recognize the necessity for broad, liberal thinking and a personalized policy of strong economic and public appeal.

The Portent of the High-Speed Diesel

AMONG the Power Show exhibits that are indicative of changes in engineering are the high-speed diesel engines. They are, in many respects, arrows pointing the way toward the employment of higher speeds for industrial prime movers.

Practically every builder of oil engines is now manufacturing, or developing, a high-speed design. These are departures from past practices, for they are not modified gasoline engines, nor heavy slow-moving diesels lightened in reciprocating parts to permit higher speeds. Problems of increased heat release have been solved by the use of special metals, while rapid combustion and flame propagation have resulted from the employment of equpiment built by pump and injection valve specialists. Apparently, the design problems so often raised by opponents of high speed have been solved, but whether the public will be convinced of the obvious advantages of high speed is as yet unanswerable.

There are several applications, such as contractors' machinery, industrial locomotives and motor boats, where high speed is imperative because of space limitations. But the total number of engines required in these fields will be comparatively small as long as there is any great price differential between oil and gasoline units. Only where the use-factor is relatively large do operating savings justify the diesel's extra initial cost.

Inasmuch as the greatest field for oil engines is the factory power plant, the engine designer, and manufacturer should develop a high-speed diesel capable of enduring the constant heavy-duty service required. The final and most essential step, convincing the potential user of the advantages of higher speeds, must also be taken before the industrial high-speed diesel can take its place among the present-day prime movers.

The chief obstacle is the prevailing idea that the machine's life is in direct inverse ratio to the speed. That this is not true when the machine is properly designed can be proved by innumerable citations. But even if it were a fact, the decreased initial investment would often justify a high-speed installation, especially since business expects obsolescence rather than wear to determine a machine's life.

Reliability is really the determining factor, and there is general agreement that reliability can be built into a fast-turning engine.

In fuel consumption the high-speed oil engine suffers none, for heat losses are less, and, up to a certain rate, combustion is satisfactory. Also, the various items of installation cost, other than that of the engine, are, as a rule, decreased with a speed increase.

It is not to be forgotten that the public expects high speed to be accompanied by reduced cost. If engine builders can materially lower the cost of the engine, there is every probability that factory managements will take kindly to the high-speed idea.

Heat Consumption, Holland Station

ONE OF THE papers presented at the annual meeting of the A.S.M.E., a short abstract of which appears in this number, contains a table of efficiency data for the first six months of operation at the Gilbert Station of the New Jersey Power & Light Company. It shows that during July and August a kilowatt-hour was produced for an average of 12,850 B.t.u.

This is the first published operating data for a plant designed wholly for 1,250 pounds pressure. Undoubtedly, engineers will compare the heat consumption obtained at the Gilbert plant with other plants operating at lower pressures.

For example, the Columbia station, a 600-pound reheat plant, produces a kilowatt-hour for about 12,450 B.t.u., and Powerton station, a 650-pound reheat plant, has averaged 12,546 B.t.u. per kilowatt-hour for a four-month period.

The natural conclusion, arrived at from these figures, would be that a 1,200-pound plant is not so efficient as a 600-pound plant. Such a conclusion, however, is not justified. The Gilbert station has been in regular operation for only six months. During this period of initial operation the plant personnel has been concerned more with getting the plant into smooth operation than with any attempt to obtain high efficiency. The economies that will be secured six months or a year hence may tell a different story.

Safe Engineering Practice Must Be the Guide

ANTIQUATED regulations covering elevator construction and operation, in New York City, have placed unnecessary and expensive restrictions on vertical transportation in modern skyscrapers. Since the present code came into existence elevator design has been revolutionized. But the old regulations are still in force to bar adoption of many improvements. The hope of building owners, architects and engineers for relief from this situation seems about to be realized in the new building code being prepared under direction of the Merchants' Association. In this code, restrictions on elevator-car speeds have been practically eliminated. Operation of double-deck elevator cars will be permitted, as will two cars in the same hoistway, such as an express and local.

A major function of any code is to establish safe practices in design and operation without discouraging improvements in the art. The elevator code at present in effect in New York City does the reverse. It allows hazardous operation and prevents the adoption of designs that are safe.

Seven hundred feet per minute is the maximum elevator-car speed permitted under the present code. Why this speed should, these days, be considered the safe limit probably no one knows. Compared to the speed at which other means of transportation are permitted to operate, seven hundred feet per minute is slow. A subway train running thirty-five miles per hour is moving over three thousand feet per minute. Even if subway trains have been surrounded by the most modern safety devices, their safe operation depends in no small measure on the human element. In the modern high-speed elevator the attendant is practically eliminated, as a factor necessary to its safe operation. It is on the slow- and medium-speed elevators in New York City, where most fatal accidents occur, and not on the high-speed machines. This indicates the fallacy of the present speed limit in the code.

Even without speed restriction, elevators will never be operated at express train speed. Only in very high buildings with long express runs is it economical to operate at speed much in excess of the present code limit. Where the higher speeds are required they should be allowed, provided it can be demonstrated that the machines comply with safe engineering practice.

An Example of Untrammeled Thought

AN EXAMPLE of the significant contributions that may be made by "outsiders" was Dr. Hirshfeld's paper presented before the A.S.M.E., assembled in New York last week for its annual meeting. Complying with the open-minded request of the railroad section, he spoke on the application of high-pressure and high-temperature steam to locomotives.

Dr. Hirshfeld's approach to the problem was particularly pleasing. Disclaiming any special knowledge of the railroad field, or any special experience in locomotive design, he threw his ideas into the ring for what they were worth.

Somewhere and somehow, the locomotive designer, like the designer of marine power plants, can reap profit from recent developments in stationary power plants. And in every other engineering branch the same assimilation of foreign ideas should improve perspective and lead to radical improvements in practice.

POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

A.S.M.E. Holds 51st Annual Meeting in New York

ROY V. WRIGHT
PRESIDENT

REFLECTING the engineer's growing consciousness of and interest in the economic and social problems of our machine civilization, the 51st annual meeting of the American Society of Mechanical Engineers, held in New York City from Dec. 1 to 5, was devoted in no small degree to a consideration of economic and business questions and the part engineering must play in their solution. Besides a large and diverse array of papers presented at the thirty-one technical sessions, ten of which were given over to power subjects, there were meetings and addresses bearing directly on the timely topics of the business depression, unemployment and the attainment of economic stability. The attendance at the meeting was over 2,500.

At the first general gathering of the meeting on Monday afternoon, Col. Arthur Woods, chairman of President Hoover's emergency committee for employment, spoke on the present unemployment situation and made an urgent plea for the engineers' help in obtaining jobs for those now out of work and in stabilizing employment in the future.

He pointed out that the interest of the federal government in the problem of unemployment and its recognition of responsibility by no means started with the present depression, but that ten years ago President Harding called together a group for a discussion of this very important question. At that time, he said, Mr. Hoover, who was Secretary of Commerce, stated that there was great need for a plan that would provide economic security during periods of depression and that somewhere a solution must be found, because such security both to employer and employee was essential to national stability. He called attention to the great ability of engineers to contribute to the solution of this problem.

That the president, he continued, has been constantly alive to the whole situation is evidenced by his constructive activity immediately following the collapse of the stock market more than a year ago. Largely through the presidential conferences the cutting of wages and the calling of strikes was prevented. It must be recognized also that the problem is largely in the state of mind of the individual and that unemployment is not due to any constitutional laziness of the people.

Colonel Woods also pointed out the tendency of idle workers to question existing conditions and the present economic order—a danger that always accompanies idleness and discontent. "On former occasions," he said, "we have been able to look to Europe as a possible aid to the rejuvenation of business. On this occasion we can not do so, as practically all the countries of Europe are in a similar state of depression. We must, therefore, look within our own country for the cure."

He called attention to the remarks of Charles M. Schwab some time ago to the effect that the engineering profession had demonstrated its ability to solve practically all material engineering problems, but that there still remained for solution the problem of human engineering and human relations. Recognition of these problems is very evident throughout the country and some of our largest industrial enterprises have developed methods for equalizing their employment. These hopeful signs, however, need extension and further development throughout the country, he asserted.

Colonel Woods then spoke of the necessity for investi-

gating the causes of unemployment and for such a condition as at present, in which there is plenty of capital but nevertheless many idle plants all anxious to work and a great number of unemployed all seeking work. Under such a condition every one loses and yet there seems to be no knowledge of how to bring these forces together. The work of the engineer during the World War was cited as a splendid example of the co-operative possibilities within the profession, and Colonel Woods closed with the suggestion that this same force, motivated by the same human ideals, can well put itself to work and again demonstrate its right for one of the most prominent places in society.

In response to Colonel Woods' plea for aid, the society adopted a program of national scope designed to speed business recovery. It will appoint a committee of five members to ascertain, first, the ways and means adopted by employers throughout the country to stabilize employment during this depression, and, second, what they have done to stabilize employment permanently. The society will then undertake to urge industry to adopt measures now for the relief of the winter emergency, will compile data on effective policies and methods used to deal with the general question of irregular employment and will assist in all other practicable ways.

W. A. HANLEY
VICE-PRESIDENT

T. R. WEYMOUTH
VICE-PRESIDENT

H. N. DAVIS
VICE-PRESIDENT

At the business meeting on Monday evening, Calvin W. Rice, secretary of the society, outlined the high spots of the society's activities during the past year and reported that it was making satisfactory progress in all its lines of endeavor.

Formal opening of the exhibition of art by engineers followed the business session. This event, unique in the annals of A.S.M.E. meetings, furnished a colorful and cultural touch to the program. L. P. Alford, chairman of the exhibition committee, presided at the opening ceremonies, at which Dean Robert L. Sackett, of Pennsylvania State College, spoke on "Art as an Engineer's Hobby," and music was rendered by the Bridge Engineers' Trio, consisting of John E. Greiner, violin; Otis E. Hovey, flute, and Ralph Modjeski, piano—all prominent consulting bridge engineers.

The exhibition itself consisted of more than 200 striking works in sculpture, oils, water colors, etching and photography, executed by professional engineers whose amateur hobby is the fine arts.

Tuesday evening was the occasion of "President's Night," at which the recently elected officers of the society were formally installed, as follows: President, Roy V. Wright, managing editor of *Railway Age*, editor of *Railway Mechanical Engineer* and a former vice-president of the A.S.M.E.; vice-presidents—William A. Hanley, chief engineer of Eli Lilly & Company, Indianapolis, Ind.; Thomas R. Weymouth, vice-president of the Columbia Engineering & Management Corporation, New York City; Harvey N. Davis, president of Stevens Institute of Technology, Hoboken, N. J.; Managers—W. L. Batt, President of SKF Industries, Inc., New York City; H. L. Doolittle, chief designing engineer of the Southern California Edison Company, Los Angeles; H. L. Whittemore, chief of the engineering mechanics section of the United States Bureau of Standards.

At this time honorary membership in the society was conferred upon Dr. Elihu Thomson, director of the Thomson Laboratory of the General Electric Company at Lynn, Mass., whose electrical inventions have given rise to more than 700 patents and who is one of the foremost scientists and inventors of his time. Ambrose Swasey, a former president of the A.S.M.E., made the presentation and paid tribute to Dr. Thomson as a man and engineer who exemplifies the highest ideals of the profession.

The personnel of the nominating committee for 1931-32 was announced as follows: S. J. Teller, Hartford, Conn.; C. P. Tolman, New York City; Harte Cooke, Auburn, N. Y.; Prof. W. R. Woolrich, Knoxville, Tenn.; Prof. A. E. White, Ann Arbor, Mich.; W. C. Lindemann, Milwaukee, Wis.; Dennistoun Wood, San Francisco, Calif.

The evening program concluded with a discussion led by Magnus W. Alexander, president of the National Industrial Conference Board, on the roles played by the engineer and the economist in our present civilization. Dr. Wesley C. Mitchell of Columbia University, director of the National

Bureau of Economic Research, and Ralph E. Flanders, vice-president of the A.S.M.E., were the speakers.

Taking for his topic "Engineering, Economics and the Problem of Social Well-Being," Mr. Flanders declared that the "complete ridiculousness" of our present business depression was apparent when we consider that there is "ample working capital, well-equipped factories, management and men eager to work and eager to buy, and yet things do not move. . . .

"It is intolerable and inexcusable," he continued, "that the business cycle should maintain its present extreme range of fluctuation. That business should pursue a perfectly level course, or even one of continuous though gradual expansion, is not to be expected. . . . It is not even desirable that there should be no fluctuations in business. But such extremes as the raging fever of the summer of 1929, or the anaemic torpor of the autumn of 1930, with all the human misery that attends them, stand as a reproach to the intelligence and good will of our race. . . .

ELIHU THOMSON
HONORARY MEMBER

Asserting that the science of economics had failed to solve these problems because it bore the same relation to business that natural science of a century ago bore to the practical activities of production, Mr. Flanders looked to the union of economics and business for help on the question. He said that "science for many generations, while tremendously affecting man's intellectual life, had small effect on his practical actions; the progress of unaided invention in its turn fell far short of the possibilities which we are realizing today. It was not until science and invention joined forces (as they began to do in the second quarter of the nineteenth century) that the modern world of the twentieth century became possible. . . . The ceremony of that union was performed in the technical school, and the vigorous child of the union is modern engineering. . . .

"It is my conviction that economics and business bear the same relationship to each other that science and invention did a century ago. It also seems clear that the newly organized schools of commerce and finance in our colleges and universities are strategically placed to solemnize the union of the two, but that the birth of the hoped-for offspring (shall we name the child "Social Engineering?") is long past due.

"To put the matter more directly, there are a lot of rude, bald, practical questions for which we need answers. These questions are in the fields of economics, business and finance; but there is no one in these fields to give authoritative answers to them."

Mr. Flanders stated that the engineer had gone as far as he could alone on the problem and that he must now join with the economist, or "anyone else who has a clear view of the situation," to create the new profession of social engineering which would find answers to these questions.

Speaking on "Economics and Social Engineering," Professor Mitchell stated that the reason why the economist failed to find a solution for the problems brought up by Mr. Flanders was due to the enormous complexity of the economic machine under which we operate. He said that the machine had been designed by no one, and that the real mystery was not that it got out of order but that it worked as well as it did.

He pointed out that the engineer must realize that in solving these problems he will be dealing with human beings in all the complexities of their behavior, and the most fundamental difficulties to be surmounted were intellectual difficulties.

"A mechanical engineer," he said, "who has developed a good idea may have trouble in getting it adopted. But history proves that you have been remarkably successful on the whole. By the often-repeated demonstration of the advantage of improving mechanical equipment, you have taught the world to accept your advice—and pay for the privilege of getting it. You can appeal to the profit incentive. . . .

"When you urge a change in economic organization you encounter all the obstacles which hamper technical changes in engineering, plus others. Usually you must convert, not the management of one business enterprise, but thousands or millions of men. You can't promise to make a fortune for any individual of the lot, though you may claim that your idea will add appreciably to the well being of every family in the country. Almost invariably your project will endanger certain vested interests, and they will attack you tooth and nail. You must defend your cause against these opponents, and carry on a campaign of education to enlighten and arouse the indifferent majority. That costs a deal of money. Unless you have riches to devote to your cause, you must raise funds from sympathizers on the basis of a quasi-philanthropic appeal. . . .

"I have stressed the difficulty of economic problems, as in duty I am bound to do. The fundamental trouble is that economics deals with the most complicated of all materials—human behavior. Man is an animal, all animals are complicated, *homo sapiens* is the most complicated and variable of the lot. He is a creature of slowly changing habits, of loves and hates, of wild impulses, as well as a creature with some capacity to reason. And a scientific enquirer can't experiment on men very effectively. They object."

Professor Mitchell concluded that the only hope for a solution of our economic problems lay in re-education,

"and re-education is a slow process. Slow, but not hopeless. The very drift of affairs is coercing us to change. Why not mix all the intelligence we can muster into this process of making over our own habits, as we put intelligence into the continual rebuilding of our industrial plants? In fact we are doing just that with increasing skill, generation by generation. If engineers will join with the other professions who are working on the problem, we should get on faster. For the present workers need a clearer vision of what is possible in production, and a more constructive attitude of mind. Those needs engineers can supply."

At the annual dinner on Wednesday evening, Admiral David Watson Taylor was formally presented with the John Fritz Medal for 1931, "for outstanding achievement in marine architecture, revolutionary results of persistent research in hull design and distinguished service as chief naval constructor during the World War." Capt. Walter M. McFarland, past-president of the Society of Naval Architects and Marine Engineers and past vice-president of the A.S.M.E., paid tribute to Admiral Taylor's outstanding accomplishments, and Bancroft Gherardi, chairman of the board of award, presented the medal. Thomas A. Edison and thirteen other members of the society were awarded special badges for their fifty-year activities in the organization by Vice-President C. E. Gorton.

H. L. WHITTEMORE
MANAGER

W. L. BATT
MANAGER

H. L. DOOLITTLE
MANAGER

The address of the evening was given by Elliott Dunlap Smith, director of industrial investigations of the Institute of Human Relations and professor of industrial engineering at Yale University, on the subject "Engineering Encounters Human Nature."

Though the engineer has achieved his goal to an unprecedented degree in devising means for the production of the material wants of mankind, said Professor Smith, he is roundly abused on all sides for his success. The reason for this, he explained, was that the engineer had created a technological age, and, unfortunately, society has not yet learned to utilize to the full the opportunities, nor to curtail the dangers which technological advance has brought about. Consequently, although the material benefits created by the engineer have been great and the extent of the latent spiritual benefits will perhaps be still greater when society organizes itself to harvest them; there is little talk of technological leisure, technological child welfare, or technological improvement of working or living conditions. Instead, the engineer is indicted for creating an age where man is enslaved by his machines, labor robbed of its soul, and life deprived of art. . . .

"For technological progress is not easily absorbed into the social structure. Its absorption usually involves adjustments of great magnitude and difficulty. To launch new technological methods into an old society is not merely to put new wine in old bottles; it is to put high voltage into old wiring. Certainly the man who does so has some responsibility to see that the wiring is suited to its load. When the engineer's conceptions pass from the stage of blueprints into actual mechanisms and processes, engineering encounters human nature, and it is an important part of the task of the engineer to see that human nature is prepared to benefit from the contact."

Professor Smith then went on to show how technological advances had been applied to the textile industry, and how in the case of one mill where the human element had been studied and taken into consideration, successful results had been obtained, whereas in the case of other mills where new machinery had been installed without regard to the human element—misunderstandings, labor troubles and loss of profit had resulted.

"As technology goes forward," he concluded, "it thus becomes of greater and greater importance that engineers, singly and as a profession, realize that they have not measured up to the full stature of engineering unless they have taken their part in solving the human problems and securing the human benefits that their material progress has created. Through the attainment of their first goal—the provision of means to supply the wants of mankind—the engineers have brought themselves in contact with a wider problem. Will not the acceptance of it as theirs, thus widening the scope of engineering, make engineering even a nobler profession than before?"

High-Pressure Plants

Discussed at Central Station Session

Following the precedent set last year, but one session was devoted to central station power, and only two papers were presented. Both papers contained eagerly awaited statements concerning preliminary operating experience gained at Deepwater and Gilbert stations, the first plants designed wholly for 1,200 lb. pressure. In the Gilbert paper data were also presented on station economy

Experience at Deepwater Station

OPERATING EXPERIENCE at the Deepwater station was related in a paper by K. M. Irwin, mechanical engineer, of the United Gas Improvement Company. The first part of this paper dealt with a brief description of the plant and will not be repeated here, as the station has been previously described. It will be recalled that the boilers are designed to provide steam to the turbines at 1,200 lb. and 725 deg. There are two 53,000-kw., cross compound units and one duplicate high-pressure element which exhausts to evaporators that supply steam to the duPont factory.

Many of the fears of 1,200 lb. pressure have been centered around piping. It was stated that to date there have been no leaks on the larger sizes of high-pressure piping, which are equipped with Sarlun joints. Some difficulties have been encountered in the smaller-sized pipes used for drips and instrument connections, most of which are chargeable to the use of composition gaskets. These have been replaced with either soft-steel or corrugated Monel metal gaskets.

Only one of the economizers has given trouble from leaks, which have been due to gaskets being improperly installed. Some of the boilers have had a number of leaks, but, in nearly all cases, after the tubes were re-rolled no further difficulty was experienced.

One of the first things discovered regarding the slag-bottom furnaces was that the furnace floors had a tendency to grow and push out the side walls. This was particularly noticed on boilers taken on and off the line at frequent intervals. It was discovered that the cracks formed in the furnace bottom during cooling, and filled with molten slag when the boilers were again heated. Repetition of this action gradually pushed the walls out so that it was necessary to cut back the furnace bottoms adjacent to the side walls and thus allow them to spring back or to be pushed back into their proper position.

The first two boilers were installed with dolomite bottoms, but mica schist was used in place of dolomite in the bottoms of the next two boilers. Operation, however, has proved that dolomite is much superior to the mica schist.

In the last two boilers the bottoms were constructed of coke and silica sand. One boiler with this design of bottom was taken off the line, and when cut into it was found that all remnants of the coke had entirely disappeared. It has now been decided to reconstruct with magnesite.

The boilers are fired with pulverized fuel, the direct-fired system being installed on three boilers and a bin system on the other three. No tests have been run, but normal operating data indicate that the systems are operating at practically the same efficiency. There is no marked improvement in the flexibility of the bin system over a direct-firing system for normal operation. The bin system does have the distinct advantage of being able to operate at very low ratings, which was of advantage when the plant was originally put into operation. The direct-fired system has a distinct low-rating limitation.

On a number of occasions it has been necessary to drop plant load because of failure of coal supply from the direct-fired system. A number of these interruptions were caused by small adjustments required on the mills. Difficulty has been experienced with coal hanging up in the raw-coal bunkers and sticking in the connections between the raw-coal bunkers and the scales.

Silica scale has deposited on the last rows of blading and nozzles in the high-pressure turbine used in the duPont system, a difficulty peculiar only to this machine. It has been necessary to shut this machine down for periods of two weeks to scrape the scale off the nozzles and blading by hand. Purifiers have been installed on the vapor outlets of the evaporators to cut down the carryover silica in the make-up water. Since these have been installed the purity of the vapor in the evaporators has been considerably increased and the turbine has operated for a period of several weeks without showing symptoms of scaling.

It is believed that the deposits occurred only on the duPont turbine because the back-pressure and dryness conditions on this unit are less than on the other high-pressure turbines. A high-pressure connection is being made to the latter stages of the duPont turbine so that this condition can be remedied.

Each of the high-pressure elements on the compound units has developed leaks on the horizontal joint. These leaks occurred on successive days and did not occur on the high-pressure unit of the duPont system. Considerable difficulty has been encountered with the governing mechanism and control valves on the high-pressure turbines. It has been impossible to run the low-pressure element of the compound machines without the high-pressure unit without breaking the stem of the control valve supplying high-pressure steam.

Operation of the Gilbert Station

EXPERIENCE gained during the first six months of operation at Gilbert station was presented in a paper by G. M. Gilbert, president, W. S. Barstow & Co., Inc. The paper contained a brief preliminary description of the plant, which contains a 55,000-kw., cross-compound unit receiving steam at 1,250 lb. pressure, 750 deg. temperature, from two boiler units designed for 250,000 lb. of steam per hour.

Control and operation of the plant on one floor without any wall between turbine and boiler room has made the Gilbert plant simpler to operate than existing low-pressure plants, and it has been found that no added personnel or higher class of labor is needed than used in low-pressure plants.

Operating data presented with the paper disclosed that during the week of July 26 the plant produced a kilowatt-hour for 0.846 lb. of coal with a heat consumption of 11,866 B.t.u., resulting

in a thermal efficiency of 23.75 per cent. The average heat consumption during the months of July and August was about 12,850 B.t.u. per killowatt-hour. Typical operating data disclosed that superheated steam temperatures of 750 deg. have been encountered with reheating temperatures of 818 degrees.

During early periods of operation composition gaskets used on the high-pressure lines of 2 in. and under gave trouble, and were replaced by metal gaskets, which have been satisfactory.

It was found that when the flanges on the high-pressure superheated lines were covered leaks developed during the change-in-temperature periods when the line was being brought up to pressure, or the pressure was being lowered. Removal of the flange covering overcame this trouble.

Minor trouble was experienced in the beginning on the high-pressure turbine, due to condensed steam from the glands getting into the oil system. Considerable trouble was experienced as a result of valve stems sticking in their bushings, and with the cam mechanism of the valve control. Leakage in horizontal joints of the high-pressure turbine was stopped by tightening the holding-down bolts.

The secondary feed pumps were originally provided with Ryan seals. These were replaced by a combination labyrinth stuffing box, which has proved very satisfactory.

The superheat obtained at the start was low, but has been adjusted by the installation of a kicker baffle. Reheat temperature was entirely too high during the first period of operation, and required the use of a desuperheater. To remedy this condition reheat surface has been removed from both boiler units. Trouble occurred in the steam reheater because of faulty welding of the high-pressure elements.

The first trouble on economizers was due to leaky handhole caps, this having been remedied by using softer steel gaskets. Later, considerable trouble developed in leaks between tubes and the headers, some of which have not yet been cured.

During the starting-up period difficulties were experienced from erosion of the fan-inlet vanes caused by high velocity when the vanes were almost entirely closed. This trouble has been overcome by installing leak-in dampers, which are used at light loads.

Due to the increase in solids contained in the raw feed water due to the high ratings at which the evaporator is required to work and to excessive economizer leakage, concentration in the evaporator and boilers was raised and caused solids to be carried over with the steam into the turbine. The turbine has been washed with saturated steam, which has proved a satisfactory cleaning method.

Both papers were discussed simultaneously, and most of it applied to both papers. S. T. Powell confined his discussion to the carryover of solids from the evaporators. The evaporators at Deepwater were guaranteed at full load to deliver steam containing not over 0.75 gr. per gallon, but actually the steam contained 4.5 gr. per gallon. This condition was due to: (1) High water in evaporator shell; (2) fluctuations due to improper functioning of drip valves; (3) high concentration in shell; (4) clogging of vanes in purifier; and (5) no baffle plate ahead of purifier section.

The high tip speeds of fans necessary to produce pressures of 12 to 20 in. has made it necessary to use heat-treated alloy steel blades. G. C. Derry cautioned against repair of erosion by welding, as this would affect the heat-treatment and lower the strength of the blades. Inlet vanes cause erosion to take place evenly over blade surface and mostly at their tip. Tip erosion does not lower strength and it is unnecessary to replace blades immediaetly. Wear that takes place on fan inlet vanes may be repaired by welding Stellite on vanes.

H. S. Whiton remarked that his experience with slag furnace of molded coke indicated it to be a satisfactory material. The slag in this case contains about 0.3 per cent iron.

Discussing the comparison of bin vs. unit systems of firing pulverized coal, E. G. Bailey pointed out that local conditions of load factor, diversity factor and fuel necessarily had a large effect upon the opinions expressed in the Deepwater paper. Although the costs of the bin and unit systems were claimed by the authors to be about the same, Mr. Bailey said in other installations the bin system costs from 25 to 100 per cent more than the unit system.

J. P. Mailler described the high-pressure plant at South Amboy, which has been in operation for something over a month. Preliminary operation brought with it very little trouble.

I. E. Moultrop emphasized the very slight increase in cost of high-pressure over low-pressure plants and that the gain in efficiency was obtained without increase in capital investment.

Replying to statements concerning the efficiency obtained with high pressures, Mr. Hackett stated that the mercury-vapor unit at South Meadow had been operating with an availability of 97 per cent, and had produced over a million kilowatt-hours for 0.712 lb. of coal per kilowatt hour and a heat consumption rate of 10,000 B.t.u.

W. S. Johnston expressed the opinion that after the Deepwater plant had been in operation for a somewhat longer time and the operators had become more familiar with the equipment the unit system of pulverized fuel would be found just as reliable as the bin system.

S. Brown observed that the average steam obtained from evaporators carried only ½ grain per gallon and that at Delray No. 3 it contained only one part per million. If sufficient size and steam-relieving space is permitted an evaporator can be made to deliver pure steam.

In closing, Mr. Irwin disclosed that during October Deepwater had produced a kilowatt for 12,419 B.t.u., which is almost exactly the heat consumption now secured at Gilbert.

Heat Absorption and Radiation

AT THE Fuels Division session on Wednesday morning the progress report, prepared by Prof. T. A. Mangelsdorf, was presented in abstract. This pointed out that the production of bituminous coal during 1930 had been at a lower rate than at any time in the past five years, but due to the marked decrease in consumption of the supply had been in excess of requirements. From the standpoint of the coal industry the situation has been unsatisfactory. However, the past year has been notable for an increase in the mechanization of mines, the continued low prices and decreased demand having brought about additional efforts to reduce production costs and increase recovery. Greater attention has also been given the cleaning of the product.

In a paper on "Heat Absorption in Water-Cooled Furnaces," W. F. DeBaufre evolved a formula based on the furnace heat balance in which the heat radiated from the burning fuel and the products of combustion leaving the furnace must equal the net heat produced by burning the fuel plus the sensible heat in the preheated air supplied for combustion. Designating the ratio of the radiant heat per pound of fuel fired to some function of the furnace outlet temperature as an "effectiveness factor," the author offered the following formula:

$$R = \frac{E}{F}\left[\left(\frac{T_G}{1000}\right)^4 - \left(\frac{T_S}{1000}\right)^4\right]$$

where T_G = Absolute temperature of the products of combustion leaving the furnace in degrees fahrenheit.
T_S = Absolute temperature of the water evaporating into steam within the water-cooled surfaces in degree Fahrenheit.
F = Fuel fired per hour per square foot of water-cooled surface exposed to radiation, in pounds.
R = Heat radiated per pound of fuel fired in B.t.u.
E = Effectiveness factor of the water-cooled surfaces.

The author pointed out that while this formula is not fundamentally sound it offers a basis for calculations.

The second paper of the session was of a highly technical nature and dealt with the "Radiant Heat Transmission Between Surfaces Separated by Non-Absorbing Media." Its author was Prof. H. C. Hottel of Massachusetts Institute of Technology.

Both mathematical and graphical solutions were offered, the latter showing the distribution of radiant heat to the various tubes of the two bottom rows of a boiler. According to this, the first row intercepts 66 per cent of the heat, the second row 22 per cent and the remaining 12 per cent reaches successive rows. If refractories are employed, some of this may be re-radiated to these tubes. The distribution of radiant heat to successive rows is almost independent of whether the tubes are staggered.

Interconnection and Byproduct Power Evoke Lively Discussion

At the session on industrial power two papers[1] were presented. B. F. Wood, president of Allied Engineers, Inc., summarized the engineering aspects of the interchange of power between central stations and industrial plants, and W. F. Ryan of the Stone & Webster Engineering Corporation discussed combined industrial heat and power supply

Engineering Aspects of Interchange of Power

TO SECURE maximum reliability and economy of power service, and the fullest utilization of any waste heat or usable surplus power, Mr. Wood stated in his paper that some arrangement must be made to bring about a massing of the industrial and utility companies' resources of power production. Among the means that may be employed to secure the advantages of massed resources and power production, with respect to utility and industrial plants, he mentioned:

1. Interconnection of the electric circuits, securing advantages of protection of service, diversity of load conditions, economy of operation, etc.

2. Establishment of jointly owned plants and facilities, supplying to the industrial plant electric, steam, or other power service, utilizing the utility system as the reservoir from which to draw or into which any and all surplus electric power may be poured.

3. Building and operation of plants and facilities by a utility company near the industrial plant, supplying such power service as required by the industrial plant, making up any deficiency from, or taking any surplus electric power on, the utility company's power system.

In the first case there are the possibilities by interconnection between different utility systems, with the further advantage, usually, of a different character and greater degree of diversity of load.

But it is the last two cases that present the greatest possibility for a mutually advantageous arrangement between industrial and utility plants and that make the engineering studies to secure maximum economic results most interesting.

Typical examples of these various cases were cited. In the author's opinion, there are undoubtedly thousands of opportunities for the establishment of means and facilities to utilize massed resources to serve the power requirements of industrial plants. The advent of high steam pressures has largely increased these possibilities and extended the engineering problems involved in their proper solution. The engineer must seek the maximum overall economy with minimum investment, having regard for reliability of service; then work out a plan for the undertaking that will be to the mutual advantage of all parties interested.

The principles of contractual relations between the industrial and the power company are simple, but their application may be complex. In principle the industrial should pay the power company a reasonable rate of return on all investments made on its account and also pay its proper share of all operating costs. In practice, it is often desired to reduce the payments to unit rates for steam and electric power.

Combining Heat And Power Supply

IN THE industrial power field, said Mr. Ryan, there are now about 200 industrial plants in the United States operating at pressures above 300 lb. gage, almost all of which have been built since 1925. The industrial plant that has a large demand for process steam has a natural advantage over the condensing central station, in that the latent heat in the exhaust is utilized and the cycle efficiency of the prime movers is 100 per cent. The quantity of power that can be generated so economically is limited by the demand for exhaust steam, but can be materially increased by raising throttle pressure.

The full economic value of the high back-pressure prime mover can be developed only by co-operation between industries and public utilities for the combined production of process steam and electric power.

For the success of such a co-operative enterprise, the first requirement is that the advantages must be equitably divided between the two parties. If the plant is owned and operated by the manufacturer, the utility must be assured of continuity of power supply. If, on the other hand, the utility owns and operates the plant, the manufacturer must be assured of the reliability of his steam supply. If a plant is built under joint ownership, there must be a just division of costs betwen the two services. All three of these plans are in use in this country today. All require mutual confidence, good engineering and intelligent management, and each party must have a sympathetic understanding of the problems of the other.

There are few industries that can generate their entire power requirements, at all times, in all seasons, as a byproduct of their process steam. There are still many such plants which generate power in condensing prime movers, but the vast majority purchase their requirements from public utilities. There is rarely any economic justification for the private generation of steam power in condensing units, although under certain conditions internal-combustion engines may be used advantageously. There is a growing tendency in this country to use the diesel engine as an adjunct to an industrial steam power plant; when the electric power demand exceeds the relative demand for exhaust steam, the deficiency is supplied by the diesel engine.

Gratifying progress has been made in the conservation of fuel by developing the high-temperature end of the industrial power-and-heat cycle. An enormous quantity of potential energy is still being dissipated in the relatively low-temperature wastes from manufacturing plants. For the present, the high-temperature field offers more at-

[1]Both of these papers were re-presented from the World Power Conference at Berlin to secure American discussion. Abstracts of both have appeared in *Power* of July 29 and July 1, respectively.

tractive return on investment, but the future will undoubtedly see much progress in the recovery of heat at low temperatures.

Opening the discussion on Mr. Wood's paper, C. F. Hirshfeld was in accord with the views presented. Keen industrial competition is necessitating the study of everything that can possibly reduce production costs. A similar motive, differently expressed, activates those engaged in the utility business, for the continuing desire here is to be able to reduce the price charged for service. These motives are driving toward a common solution which rests, in the end, on diversity. Interconnection with industrials brings in a new set of diversities that can be used to the advantage of both the industrials and the customers of the utilities. Progress in this direction will not be made without great difficulty. There are many complicating factors, psychological, physical and economic. A comprehensive statement of these difficulties is necessarily the first step toward their solutions. One of these difficulties briefly outlined is the question as to how far the utility is justified in advancing the necessary investment on the assumed continuing solvency and business activity of a single large industrial.

INTRODUCING discussion on combining heat and power, John H. Lawrence pointed to the enormous field for improvement in the industrial power field and the necessity for the engineering profession to educate the industrial executive in the economics of steam and power generation. He should be taught to look at his power plant from the standpoint of the economical production of power and not of the necessary expense of providing something with which to drive machinery. Whether to generate or to purchase power, economics should govern. Under certain conditions large savings are to be anticipated from interconnection. However, the industrial operator should not be content merely because he has an interconnection; either way, he should know that he is using heat in the most economical manner.

Guy B. Randall thought that the great possibilities in obtaining more and cheaper power lie in joint ownership by utility and industrial, and in simple connection of electric circuits. The former might develop a fair field of action in some of the larger projects, but there were serious objections from the standpoint of the industrial unless the utility uses the new medium to insure the equivalent of far more favorable rates relatively than present rate structures provide. Also his observation indicates that the savings to be derived by the industrial plant are reduced by the higher cost of public utility construction and the profit the utility must earn.

Simple interconnection of electric circuits seemed to Mr. Randall to offer the essential opportunity for development. Under this scheme, if the isolated plant has surplus power it dumps it into the general pool of power. If it needs some, it draws from the pool of power. There are no financial complications. But it must get paid reasonably for what it delivers and it must pay reasonably for what it gets.

R. J. S. Pigott said that the main obstacle to the more rapid development of interconnections between utilities and industrials is lack of confidence of the two groups in each other. Industrials, particularly the larger ones, regard their own supply of power as more reliable, which usually is contrary to facts. Utilities on the other hand offer another obstacle in that it has become their custom to regard industrial power as off-peak or dump power and to rate it as only valuable to the extent of fuel increment cost. They are only willing to offer figures of 1 to 1½ mills per kilowatt-hour delivered to their lines, whereas the current they furnish may be charged at 7 to 9 mills. Many of the plants considered for interconnection or combination service will be delivering large quantities of power which is not dump power. In this case it is worth just as much to the utility, provided it is reliable, as if they made it themselves.

Another obstacle has been methods of figuring costs. To this end are needed standard methods of accounting for costs which will be accepted by both groups and some method of valuation of reliability that is based on other things than opinions.

Edgar J. Kates referred to the excessive rates many public utilities charge for breakdown service. If this kind of service were cultivated, he considered it likely that the diversity factor would be much larger than that of any other class of service. Consequently only a small fraction of the maximum breakdown demand on any one customer needs to be reserved for his use, and this justifies a large reduction in the service charge. Referring to the suggestion in one of the papers to add a diesel engine as an auxiliary to a complete steam plant to perfect the heat balance, Mr. Kates suggested that the idea be carried further in that a combination plant be designed instead, with steam and diesel capacity carefully proportioned so that the load will be shared in according to an analysis of capital investment as well as operating cost.

THE DESIRABILITY of generating byproduct power is being answered on its economic merits, said E. D. Dickinson. That the manufacturers have anticipated the use of byproduct power to its economical limit is manifested by the many recent installations of highly efficient back-pressure and extraction turbines. To insure the greatest gain careful study of all operating conditions before proportioning the turbine is of the greatest importance. Mr. Dickinson expressed the opinion that the matter of bookkeeping is one of the most important, and yet most unreasonable, elements tending to retard byproduct power development. Figures are convincing, but if they are based on unsound presumptions they will lead to false conclusions.

Z. G. Duetsch felt that the extension of interconnection between utility and industrial did not alone wait for a financial understanding together with an equitable means of bookkeeping, but that more often the difficulty is the amortization of present invested capital in power-producing equipment, which even though obsolete from the standpoint of utmost thermal efficiency, is still in good physical condition. Often the consumption of process steam can be reduced enormously. In making a study for the purpose of recommending unification of power-generating facilities, the speaker recommended that the heat balance of the industrial plant itself be studied carefully to make sure that the portion of the low-head heat required in process cannot be obtained through some means of recirculation.

DISCUSSING interchange of power, James M. Taggert suggested that each case involved special engineering and economic features that require study to solve effectively. Just as the arrangement of each co-operative plant is special, so also is the value of the heat or power interchanged. As a rule, in addition to the reduction in total B.t.u. required, there should be a reduction in total investment and an increase in reliability of operation. Unprejudiced and accurate engineering is required to achieve mutually profitable and efficient co-operation.

Charles W. Conrad supplemented Mr. Wood's means of securing advantages of massed resources of power production with the proposal that the utilities plan for manufacturing districts around their large generating stations. Land or buildings could be leased or sold to manufacturers planning new factories or branch factories.

In the oral discussion Paul Lupke, Jr., suggested that it was a difficult problem for the operating man to make good economical use of a byproduct power layout. He had to face seasonable changes and changes of output, product and heat requirements. In his opinion the plant designer should pass along information that would help in the operation of a plant of this kind.

To those sitting on the outside Harvey N. Davis thought there was something more in the power situation than mere economy. Long-range public good demands that we use our coal resources just as well as we know how. If it does not pay to do this in any specific case then the set-up should be changed so that it does. Within the range of sound economics often various choices can be made. Preference should be given to the factors having the most of public welfare in them.

Preceding the industrial power session a group of about fifty industrial power engineers met at a luncheon conference to discuss problems of mutual concern. The discussion brought out a lively interest in feed-water problems of high-pressure industrial plants and in interconnection between industrials and central stations, as well as in various problems of the small plant.

Report of the Hydraulics Division

Design Principles Co-ordinated

THE Hydraulic Division held its annual session Tuesday morning. The annual progress report of the division was presented by Byron E. White, general engineer, Utica Gas & Electric Company, and secretary of the Hydraulic Division. The report pointed out the growth of understanding among hydraulic engineers of the principles involved in the construction of hydropower apparatus and their increasingly intelligent application in present-day designs.

Notice was taken of the apparent growth of feeling on the part of the public toward the public utility corporations and the consequent political effect discerned by the utilities when dealing with governmental agencies. It was felt, however, that a better understanding is rapidly being achieved and that an evidence of this is seen in the methods by which negotiations were conducted for the disposal of the power output of the Colorado River Hoover Dam project. Tendencies of regulatory procedure were discussed.

Growth in the utilization of models for experimental testing of hydraulic designs was emphasized, not only as it applies to dams and other hydraulic structures, but to the power generating machinery as well. Particular mention was made of the installation of cavitation laboratories in this country, as well as in Canada and Germany.

Construction of new hydraulic turbines for the year was reported and special mention was made of the growing use of the Kaplan turbine, both in America and abroad. Other hydraulic turbines of large physical dimensions, such as the 57,000-hp. unit at Spiers Falls, which operates under 81 ft. head, and the 84,000 hp. unit at Dnieperstroy, Russia, for 116-ft. head, were reported. Progress was mentioned in the use of babbitted and rubber-lined turbine guide bearings and other details of turbine design. Butterfly valves have been experimented with successfully for the control of free discharge water through dam outlets and the like. Improvements of control devices and methods of long distance indicating were discussed. This subject was carried into the consideration of automatic operation, in which new methods and devices have had the effect of greatly increasing the efficiency of plant operation through the automatic and selective operation of the different units in a power system according to low demand.

The report emphasized the growing popularity of motor-driven governor flyballs, and pointed out that by adding three slip rings to the pilot exciter its voltage output is practically steady and the operation of the governor flyballs is greatly improved. The increased use of pumped-storage hydro plants in Europe was commented upon, although it was stated that there is wide diversity of opinion as to the value of this plant in the United States.

The subject of dissipation of energy of large volumes of waste water and the methods for accomplishing it under different conditions was given some space. The report closed with a discussion of the competition of oil engine power with steam and the relation between steam and hydro. It also pointed out improvements in construction machinery specially adaptable in hydro plant installations.

An interesting discussion upon the general subjects of the report followed, during which a number of points of general interest were developed. Plans for the annual report for next year will include also some information in the field of pumping and general construction, and an effort will be made to specially mention novel developments.

Federal Relations To Hydro Development

THE SECOND PAPER on the program was by Frank E. Bonner, executive secretary of the Federal Power Commission, and entitled "Federal Relations to Water Power Development." This was a splendid and decidedly enlightening discussion of the developments in water power regulation, control and licensing as practiced by the federal government. In view of the rapidly changing conditions under which the Federal Power Commission has been called upon to administer the federal laws upon water power, Mr. Bonner's paper will be found of particular interest by those engaged in or contemplating the production of power from water lying either in whole or in part within the public domain.

It discussed the "real estate holdings" of the government and the federal responsibility resulting therefrom. Federal jurisdiction over navigable streams, on which there is considerable contention at the present moment, was spoken of, and certain Supreme Court decisions were cited as a means of clarifying the position of the United States government with respect to this mooted question. The purpose of the Federal Water Power Act was then taken up. This was followed by a citation of the activities of the commission and closed with a statement as to the aggregate capacity of water-power plants under license.

Although essentially factual in character, a written discussion of Mr. Bonner's paper was received from Guido H. Marx, professor of machine design at Stanford University, California, strongly criticizing the Federal Water Power Commission. He expressed his belief that the commission favored the largest developers of water power to the exclusion and detriment of the small man. He also expressed himself freely with respect to his views upon state regulation and federal regulation.

W. S. Lee, consulting engineer, vice-president and chief engineer of the Duke Power Company of Charlotte, North Carolina and president of the American Institute of Electrical Engineers, followed with a broad appeal for logical and unemotional consideration of the whole problem of water powers, their administration and regulation. He pointed out that water-power projects were becoming increasingly expensive to develop as the available sites were getting scarce and consequently further away from the centers of electrical consumption. The cost of water rights and the construction necessary for the rebuilding of roads and provision of various replacements and reimbursements for property taken over in the construction of storage dams and the like were items of cost which frequently decided the economic possibility of the installation. The need for a better popular understanding of the problems of water-power development was pointed out and Mr. Lee expressed the hope that such large and unbiased institutions as the national engineering societies would feel it a part of their civic duty to aid in the dissemination of educational information to the public, such as would enable the people at large to judge the merits of these controversial matters without dependence upon the viewpoints of those avowedly on one side or the other.

Blake R. VanLeer, assistant secretary of the American Engineering Council, added some further information to the meeting with a discussion of the new regulations in the Water Power Commission and stated that, of the five commissioners the law required, not more than three shall be of one political party. The hope was expressed that the appointments to the commission would include some engineers. At the present moment no appointments have been confirmed.

Following a general discussion, which was entered into by Irving Moultrop, Dean Sackett of State College, Pennsylvania, and others, a resolution was adopted by the Power Division appointing a committee to develop suggestions and means for carrying out a plan of general education on water power matters and suggesting that the

American Society of Civil Engineers and the American Institute of Electrical Engineers should be apprised of the action with the recommendation that they appoint similar committees, all of which would offer their services to American Engineering Council and otherwise act together for the dissemination of unbiased information dealing with the whole subject of water power, for the benefit of the membership of the engineering organizations as well as for that of the public at large.

Owing to newspaper reports that the National Electric Light Association was also included in the organizations requested to appoint committees, it should be pointed out that the resolution passed by the Hydraulic Division did not include any suggestion that the National Electric Light Association be included in the plan.

Standardization of Centrifugal Pumps

A PAPER by Joseph S. Stepanov, research engineer of the Worthington Pump & Machinery Corporation, entitled "A Method for the Standardization of Centrifugal Pumps," emphasized the increasing use of scientific methods in the solution of engineering problems. The author illustrated his point by discussing a possible combination of the preferred-numbers idea and the law of similitude for the development of a rational line of centrifugal pumps. The plan, in Mr. Stepanov's opinion, will result in the development of a pump series which will consistently cover the field and avoid unnecessary overlap of sizes.

A mathematical treatment then followed, by which the author developed a set of geometric series that conforms to the preferred-numbers table. The mathematical treatment, together with illustrations, tables and diagrams, did not lend itself to satisfactory abstract. The application of the law of similitude to pump design was set forth and later related to the proportioning and standardization of hydraulic and mechanical parts.

Owing to the strictly technical nature of the paper, the discussion was rather limited. J. W. Macmeeken of the Byron Jackson Company, Berkeley, Calif., presented written comments. He stated his opinion that the preferred-numbers system was a happy suggestion, but that he thought manufacturers and designers would generally develop their own numbers based upon personal experience and influenced by the increasing knowledge of the design-faculty of the individual himself.

S. A. Moss of the General Electric Company, at Lynn, wrote suggesting that the reference numbers as adopted by the American Standards Association might well be fitted into Mt. Stepanov's plan.

High-Pressure and High-Temperature Steam In the Locomotive Field

SOME interesting thoughts on possible developments in locomotive practice were presented on Tuesday morning by C. F. Hirshfeld, chief engineer, Research Department, the Detroit Edison Company. In presenting his paper, at the request of the Railroad Division, Doctor Hirshfeld disclaimed any special knowledge of locomotive practice, but offered his suggestions subject to further checking by railroad motive-power specialists.

Doctor Hirshfeld's paper outlined recent developments in high pressures as applied to condensing and non-condensing stationary plants, and then showed additional factors that might affect their application to locomotive practice.

Throughout he emphasized the importance of breaking away from tradition. "I am convinced," he said, "that when the progress of stationary plant engineering, during the first period of the present century, is viewed in retrospect, the most striking characteristics will be found to be the willingness of the leaders to cut loose from the past and to try new things, to strike out boldly into unexplored fields.

The paper emphasized the fact that thermal efficiency does not increase indefinitely as the pressure is increased. The author reviewed the known relation of net heat consumption to pressure for the Rankine cycle with and without stage heating for condensing and for non-condensing plants.

More significant, said Doctor Hirchfeld were his curves for the net power available from a given weight of steam exhausting to 5 lb. back pressure, with various initial pressures and temperatures. He stressed the significance of the curves showing the effect of initial steam conditions on the physical size of the engine. These showed a very great decrease in engine size with increased pressure up to 600 or 800 lb., with little gain beyond that point except with very high steam temperatures.

Discussing the application of higher temperatures, Doctor Hirshfeld concluded that locomotive designers would be limited to steam temperatures of the order of 800 to 850 deg. if restricted to carbon-steel tubing, but that this limit could probably be extended to 1,000 or 1,100 deg. if the cost of more expensive alloys could be justified. As to pressures, he said: "If one chose about 800 deg. F. as the highest temperature, which now seems reasonably possible under locomotive conditions, it would appear from thermal considerations as though a pressure in the neighborhood of about 800 lb. might be usable for non-condensing operation."

He laid great stress on the necessity of pure water, and pointed to this as a possible limiting factor. "In fact," he stated, "I greatly doubt whether operation at a pressure as low as 400 lb. could be conducted commercially without great improvement over present feed water practice." A possible solution suggested was condensing operation, even at atmospheric pressure. Doctor Hirshfeld suggested the possibility that the locomotive boiler of the future may be of the water-tube type with pump circulation.

Doctor Hirshfeld's paper, in accordance with the intention of its author, provoked considerable discussion. In the main, the speakers arranged themselves into two groups, one group agreeing with Doctor Hirshfeld that the time is ripe for basic changes in locomotive design, the other feeling that nothing revolutionary is called for and that the sound course is to continue developments along present lines. More of the speakers inclined to the former view.

Congratulating Doctor Hirshfeld on his broad and dispassionate approach, H. B. Oatley, vice-president of the Superheater Company praised him for recognizing the natural limitations imposed on the locomotive power plant. He agreed that the conventional form of locomotive boiler has nearly reached the limit of its usefulness and pointed to the flat stayed surfaces of the firebox as a type of construction that should be scrapped for steam pressures above 300 lb. In place of it he would use the water-tube firebox. Mr. Oatley agreed that higher pressures will save weight.

James M. Taggart, New York consulting engineer, agreed that the fire-tube boiler is unsuitable for high pressures. He suggested that economizer and air heaters should be used with high pressures. He also urged more consideration for pulverized-coal firing. Another speaker reported excellent operating results obtained with a 500-lb. locomotive.

The conservative viewpoint was expressed by Prof. A. J. Wood, Pennsylvania State College. Locomotive design has kept pace with that of stationary power plants, he declared, saying that it would be unwise at present to seek revolutionary changes. Professor Wood was, however, favorable toward careful consideration of pulverized-coal firing.

Dean Potter of Purdue University announced that the Babcock & Wilcox Company will deliver to his laboratory this month an experimental boiler designed to operate at pressures ranging from 3,500 lb. to 4,500 lb. and a temperature of 833 deg. The capacity is 5,000 lb. of steam per hour.

In closing Doctor Hirshfeld again expressed his belief that industry needs, above everything else, men who can free themselves from preconceived ideas and study their problems anew from the ground up.

New Method for Evaluating Oils

Under the auspices of the Petroleum Division a session was devoted to lubrication engineering, with William F. Parish presiding. Crane, steam-turbine, diesel-engine and aviation oils were considered and an outline given of the new navy work-factor method of evaluating oils

Crane Lubrication

A FEW YEARS AGO Eustis H. Thompson was given charge of the crane equipment of the Baltimore Copper Smelting & Rolling Company. At that time the company had thirty-seven bridge cranes, principally of 10 tons' capacity; six monorails, two of which were just going into operation; six furnace-charging machines; and about a dozen hoists. Within about three years one monorail and six bridge cranes were added, and shortly after, as a result of some changes in ownership, four bridge and two monorail cranes were removed from the group.

After the war came a period of increased production, during which the increased crane activity developed many weaknesses. In fact, delays were so much in evidence that on one occasion, when the entire equipment ran a week without once delaying production, it was felt that a record had been made.

It soon became apparent that lubrication trouble was responsible for a large amount of delay and maintenance expense. For instance, an important crane went out of commission, shutting down a department for half a day, on account of a bridge journal's running dry. Armature changes were similarly frequent, and repairs high. The majority of armatures turned out to be oil-soaked. The most frequent direct complaint was lack of lubrication.

One of the first things done was to get the elementary matter of lubricating the cranes on a more dependable working basis.

With the foregoing as a background, the author considered general crane lubrication, including discussion, on stock lubricants, gear coatings, oils and grease. Grease-cup troubles were enumerated and attention given to gear lubrication and certain lubricating problems, such as oil leakage on monorail hoist armatures, the oil-tightening of motor bearings, changes to prevent oil throwing, and the lubrication of hoist-motor brakes.

Discussion on this paper brought up the importance of using a cable lubricant that would penetrate to the interior, suitable gear lubrication, and the necessity of changing and cleaning oils periodically. Mixing oils in the shop was considered poor practice, as it tended to eliminate uniformity in the lubricant. The most suitable, rather than the cheapest, oil was indicated as the lubricant to purchase, because its use results in lower maintenance and less power consumption.

Work Factor of Lubricating Oils

SPECIFICATIONS for lubricating oils embodying the standard tests are of value, said James G. O'Neill in his paper, when they cover a narrow range of oils made from a crude and by processes of refinement known to yield satisfactory oils. When such specifications are used for oils made from widely different crudes or by widely different methods of refinements their value is doubtful. A test is needed to give true information of their suitability.

To evaluate lubricating oils and to determine their suitability, the author proposed a work-factor evaluation method gradually evolved from an accumulation of information over a long period of time of the behavior of oils in service and their behavior when subjected to an endurance test simulating service conditions. In reality it is an accelerated service test for lubricating oils carried out in a rugged machine equipped with a test journal, which operates at a fixed speed and bearing pressure continuously for 100 hr., without means for heating or cooling the oil. In many tests all oils showing abnormal increases in viscosity, acidity, asphaltic matter and carbon residue are rejected. Acceptable oils do not increase beyond definite limits in these properties.

It should be understood that it is not the purpose of the endurance test to replace the standard tests for lubricants but rather to increase the usefulness of these tests in determining the suitability of lubricating oils and in evaluating them.

A description of the method and apparatus of the endurance test was given, and the concordance was shown of results obtained when different machines are used to test the same oil. The work factors of turbine, diesel-engine, and aviation oils were discussed with relation to their performance in actual service. Endurance tests of turbine oils have proved so satisfactory, the conviction is growing that this test is more reliable in indicating the quality of an oil than a single service test. Conditions may arise during a service test that may have a deleterious effect on the oil, for which the oil is not responsible; in an endurance test this is not so probable.

For diesel engines it has been found that a high-work-factor oil proves more stable and is a better lubricant than a low-work-factor oil. Less troubles are experienced with high-work-factor oils, and oils that have passed satisfactory endurance tests also have passed satisfactory service tests.

The work factor of aviation oils was discussed and mention made of the advantages of the navy's method of purchasing oils on the work-factor basis.

Steam-Turbine Oil Stability Evaluated

IN THE final paper of the session "Evaluation of Steam-Turbine Oil Stability," C. M. Larson contended that various turbine oils in the presence of different combinations of heat, air and water deteriorate at varying rates. The usual measure of stability, he said, is determined by four things: (1) How fast the turbine oil decomposes; (2) resistance to emulsion; (3) loss through evaporation; and (4) whether the oil becomes corrosive. The practical test by placing the oils in the steam turbine and recording the changes in characteristics or analyses is tedious work, as it takes months to evaluate turbine oils in actual service. Then too, owing to the variation in conditions under which turbines are operated, it never has been possible to make a direct comparison of the sludge and emulsion percentage increases between two oils while in service or even two lots of the same oil.

To simplify the procedure and have a compact test for steam-turbine oils, a navy work-factor machine was procured and used successfully for evaluating lubricating oils.

Navy formulas, however, for grading turbine oils did not seem quite complete. Data were presented to show that the navy work-factor method, although sufficient in itself to indicate the rate of decomposition, loss through evaporation and the corrosive tendencies in steam-turbine oil, failed to measure definitely

the resistance to emulsion. By taking into consideration the demulsibility at 130 deg. F. of samples taken every 25 hr. during the 100-hr. navy work-factor run, the emulsion tendencies can be recorded as well, and this demulsibility change the author considered a real measure of the stability of steam-turbine oil.

Discussion on these two papers turned to turbine oils and their exposure in service to heat, air and water. Elimination of moisture from the test apparatus might lead to erroneous results, it was said. The rate of formation of sludges and emulsions that tended to clog the lubricating system have an important bearing on the suitability of an oil. The nature of acidity was important, as it might not be corrosive. In addition to the work number derived by the navy method, oiliness is one of the factors that must be considered. Machines are now available to measure oiliness by determining the film strength. Loss in film strength from deterioration of the oil in the work test can be shown.

Lubrication Research

MATHEMATICAL treatment of lubrication-film problems is, in general, difficult. A new method of attacking these problems was given in a paper, "Problems in the Theory of Fluid-Film Lubrication, With an Experimental Method of Solution," at the research session, by Albert Kingsbury. A method was described by which a fairly accurate solution can be obtained experimentally through an analogy between electric potential and current flow in a conductor and pressure and volume flow in the lubricating film. Electrical measurements are made upon enlarged models of the lubricating film, the models being bodies of conducting fluid contained in wooden boxes having forms determined by theory.

One of the boxes used in the experiments had inside dimension 16x8 in. in plan. The bottom of the box was of such a shape as to give a ½-in. depth of solution on one side when on the opposite side a depth of 4 in. obtained. The surface was laid off in 2-in. square area and provision made so that current could be conducted into the fluid at the center of each area and the potential distribution measured at their corners.

An aqueous solution was used in the models. In some of the experiments relating to plane bearing surfaces, the test bath constituting the lubricating film model was a solution of pure cupric sulphate in distilled water. Pressures at points in a film having been deduced from the electrical data, graphical or other means of integration were used to determine the total load, the friction, and the quantity of flow at the edges of the film. The results of the tests of the method indicated a degree of accuracy sufficient for engineering purposes, the experimental results agreeing closely with the theoretical values in all cases when the latter were available.

Long-Distance Transmission Of Natural Gas

IN THEIR PAPER, "Long Distance Transportation of Natural Gas," G. L. Rhodes and E. G. Hill presented the problems of the comparatively new industry of natural-gas transportation.

As the authors pointed out, not many years ago 100 miles was a long distance to transport natural gas, and an 18-in. line was a large line. Up to five years ago the longest distance of gas transportation in major quantities was from the West Virginia gas fields to Cleveland, Ohio. That system was relatively complicated. It involved a series of lines from the various West Virginia pools to a central-line compressing station at Hastings, W. Va., with a multiple-line system from Hastings to Cleveland, the distance being approximately 121 miles. The principal line from the fields was a 20-in. line extending from the Jackson field compressing station to the Hastings station 121 miles long, but only about 40,000,000 cu.ft. per day was transported the entire length of that line. Probably the average distance of transporting the gas was less than 200 miles. The gas was compressed in the field and recompressed once in transit.

The construction, in 1926, of the Interstate Natural Gas Company's 22-in. line, 170 miles from the Monroe, La., gas fields to Baton Rouge, La., and in 1927 of its 18-in. extension of 90 miles to New Orleans for the Southern Gas & Fuel Company marked the beginning of a new era in long-distance natural-gas transportation. Since that time the construction of longer lines has been frequent, and at the present time there is under construction the 24-in. line approximately 1,000 miles long from the Amarillo gas fields to Chicago which will have a capacity in excess of 200,000,000 cu.ft. per day.

The generally used formula for pipe line capacity and horsepower shows some interesting and important features when applied to a long line which requires many compressing stations. The old practice of laying out a system with compression ratios chosen to develop the maximum power in the compressing cylinders leads to surprising results if applied to a long line. It is generally known that even with one compressing station on a pipe line any attempt to increase the capacity of the line by enlarging the station requires a greatly disproportionate increase in power. In the case of a long line with many stations of the usual type taking the fuel from the line, this fuel, in the case of high compression ratios, literally "eats its head off." In fact, the maximum delivery capacity of a long line is reached at low compression ratios.

It takes from 10.5 to 11 cu.ft. of 1,000-B.t.u. gas to develop one compressor horsepower-hour, and about 12 cu.ft. to cover the over-all station use, according to the authors. At high compression ratios the power and fuel required become so great that the net capacity of a system reaches a definite maximum at suction pressures increasing with the number of line stations.

Compressing-station buildings are almost never of brick or similar construction, galvanized iron or sheet asbestos wood on steel framework being the usual practice. Good ventilation is a prime requisite to insure the rapid removal of the inevitable gas leakage from around the stuffing boxes of the compressors. In order to minimize the amount of possible leakage it is the practice to have the smallest possible number of joints within the building.

All electric lights and wiring are generally placed in vapor-proof fixtures, and no switches are permitted within the building. No electric motors are used in the main building except occasional fractional-horsepower, totally inclosed fan motors. The limitations of the electric system require a separate auxiliary power building in which all electric power is generated and controlled, and in which there are commonly located the compressors for starting-air, the ignition storage battery and the watersupply pumps.

The size of unit most commonly used in pipe line work is 1,000-hp. in a duplex-tandem, four-cylinder, double-acting engine, driving duplex single-stage compressor cylinders. Mean effective pressures of 70 lb. per square inch in the power cylinders are the limits of good practice. A piston velocity of about 750 ft. per minute is commonly considered the limit. The power cylinders are 21 to 22 in. in diameter, with a 36-in. stroke, operating at 125 r.p.m. The compressor cylinders are of a diameter to load the engine under pipe line pressures. It is also common practice to use unloading valves on the compressor cylinders, the opening of which increases the clearance, thus making it possible to operate under a wide range of compression ratios at essentially full load on the engines.

Larger engines of 24- to 25-in. power-cylinder diameter with 36-in. stroke are now coming into use. These engines will develop about 1,300 hp. They are less expensive per horsepower and permit considerable savings in construction costs.

The ratio between the amount of gas actually transported and the capacity of the system to transport gas is a matter of fundamental importance, particularly in a long line, where the cost of transportation is large compared with the cost of gas in the field. On long lines, therefore, it is particularly important to develop business which will show a high use-factor of the capacity provided. In general, long lines have been and are being built primarily to serve industries which operate continuously.

Research Yields New Tests for

Boiler Furnace Refractories

Despite the development of water walls in recent years, the subject of refractories continues to attract much attention. A session devoted to this subject on Thursday afternoon was equally notable for the practical value of its contributions and for their scientific approach to this difficult problem

An Operating Comparison

RESULTS of an investigation conducted by the Engineering Experiment Station of the University of Illinois were reviewed by R. K. Hursh, professor of ceramic engineering at that institution. The investigation dealt with the comparative resistance of refractories to coal-ash slag. Professor Hursh summarized his conclusions as follows:

"The effect of varying reducing conditions in the furnace on the corrosive action of slag from Cahokia coal ash is slight in the tests in the laboratory furnace.

"The temperature gradient in the refractory is an important factor in slagging action in two ways. With refractories of very high thermal conductivity the rate of heat loss through the body is sufficient to maintain a viscous slag at or near the contact, thus reducing slag penetration and corrosion. In the case of fireclay brick the conduction is not sufficient to have this effect, but materials of lower conductivity show somewhat better resistance to slags.

"Materials of low refractoriness or fired at too high temperatures reduced resistance to slag action, apparently due to diffusion of slag in the glassy portion of the body.

"The development of a vitreous and impervious layer of the body, without excess of glass, next to the slag contact reduces corrosion. Bodies of very high refractoriness, which do not so vitrify at furnace temperatures, permit slag penetration and are more affected by slags than less refractory bodies.

"A high-alumina brick showed less resistance to high-lime slags than did fireclay brick, but a greater degree of resistance to slags of low-lime and high-iron contents.

"Increase of furnace temperature produces a marked increase in the erosion of refractories by coal ash. The order of resistance of fireclay brick was not changed with temperature variation.

"Tests of special mixtures indicated an advantage for dry-pressed and stiff-mud bricks over hand-made, somewhat proportionate to their comparative densities.

"High-firing temperature tended to increase slag action of one fireclay mixture when subjected to slag action at a furnace temperature of 2,800 deg. F. At 2,600 deg. F. no difference due to firing was observed.

"A fireclay brick may afford better comparative resistance to one slag or set of operating conditions than to another; a selection may therefore be based on specific performance with respect to a given slag."

Action of Slags on Fire Brick

FOR some time investigations of refractory ash mixtures at various temperatures have been carried on at the Columbus branch of the United States Bureau of Standards. Results obtained in this work were interpreted by C. A. Klinefelter, superintendent at the Columbus branch, and E. P. Rexford, research associate for the A.S.M.E. at the same institution.

In testing a given combination of refractory and ash, a minature crucible is made by drilling a hole in a small cylinder cut from the brick to be tested. This crucible is filled with sintered coal ash and coal, or a piece of slag from the boiler setting under investigation. It is then suspended in a furnace with a thermocouple next to it. The furnace is heated rapidly to the desired temperature, and is held there for from 4 to 24 hr. The sample is then quenched to fix the actual state of the constituents just prior to quenching.

The investigators reported that for each combination of ash and refractory there are three ranges or conditions, as follows: First is the lower temperature range, where the glassy constituents of the slag cannot dissolve the refractory because the slag is saturated with solid material from the ash itself. This was pronounced a safe working range for the given combination.

Next is a critical temperature range, where most of the crystalline phases from the slag components have come into solution and the slag is mostly liquid. This represents the danger point at which the "glass" can just dissolve all of the available solid material in the slag. Any further rise in temperature will result in severe corrosion.

Finally, there is the upper temperature range, where severe refractory corrosion begins, increasing rapidly with further increase in temperature.

The accompanying table, presented by the authors, reveals an interesting correspondence between the results of such tests and actual operating experience with various fuels, types of refractory and furnace temperatures. It will be noted that in every case operation was satisfactory where furnace tempera-

FIELD AND LABORATORY DATA OF BOILER FURNACES INVESTIGATED

Station	Equipment	Fuel	Average Temperature for Average Rating, Deg. F.	Critical Range, Deg. F.	Service of Refractory in Boiler Setting	Crystalline Compounds Present in Slag
Lowellville, Ohio	Underfeed stoker	Bituminous coal	2000–2300	2700–2750	Very good	Mullite
Trenton Channel, Detroit, Mich	Long flame burner	Powdered bituminous coal	2600–2700	2700–2800	Good	Mullite, magnetite
Westport, Baltimore, Md	Underfeed stoker	Bituminous coal	2400–2600	2650–2700	Good	Mullite, magnetite
East Peoria, Ill	Long flame burner	Powdered bituminous coal	2200–2300	2200–2300	Fair	Anorthite, magnetite fayalite
Fisk Street, Chicago, Ill	Traveling-grate stoker	Bituminous coal	2600–2700	2600–2700	Fair	Mullite, magnetite
70th St., Cleveland, Ohio	Forced-draft traveling-grate	Bituminous coal	2600–2700	2700–2800	Fair	Mullite, magnetite
	Natural draft		2300–2500		Good	
Nanticoke, Pa	Traveling grate	Anthracite	2500–2600	2200–2300	Poor	Mullite, magnetite
Crawford Avenue, Chicago, Ill	Chain grate	Bituminous coal	2800–2900	2500–2550	Poor	Mullite
Cahokia, Ill	Long flame burner	Powdered bituminous coal	2600–2700	2200–2250	Very poor	Mullite, magnetite

ture did not exceed the critical range determined by tests.

The laboratory studies showed, the authors pointed out, that in some cases the boiler temperature can be increased without serious detriment to refractories in use, while in other cases considerable improvement may be expected if other combinations of coal ash and refractory are used.

The authors mentioned some investigation made along this line in the case of Cahokia and Trenton Channel coal-ash refractory combinations. The Cahokia refractory was tried with the Trenton Channel coal ash, and resulted in a decided raising of the critical range. Likewise, the Cahokia coal ash, in combination with the Trenton Channel refractory, resulted in an increase, although not to the same extent. In concluding their paper, Messrs. Klinefelter and Rexford stressed the ease with which their test method could be applied practically to the selection of better combinations of ash and refractory.

Discussing the paper of Professor Hursh and that of Messrs. Klinefelter and Rexford, E. G. Bailey, president of the Fuller Lehigh Company, said that the use of boiler furnace refractories will continue because good efficiency cannot be obtained at low ratings with a cold furnace.

Doctor Hirshfeld, as presiding officer, agreed that refractories still fill a very definite need, particularly in boilers of moderate size. He said that $35,000 has been spent so far on the refractory investigation and that an additional expenditure of the same amount, or less, would undoubtedly complete it. This, he felt, would be a small price to pay for a practical solution of the refractory problem, now in sight.

Percy Nichols of the Pittsburgh Experiment Station, United States Bureau of Mines, referred to the paper of Klinefelter and Rexford as the first giving a real laboratory measure of the effectiveness of refractories. He suggested, at the same time, that further study might reveal other factors of importance, for example, viscosity of the slag.

Differences in Refractory Service

A PAPER by Albert C. Pasini and Edward M. Sarraf presented in great detail the results of tests made at the Connors Creek power house of the Detroit Edison Company to investigate reasons for a notable difference in refractory service in two boilers of almost identical design.

The tests indicated that variation of the fuel bed thickness has a great bearing upon the life of the refractory brick. According to the authors, a heavy fuel bed produces a more strongly reducing atmosphere and higher furnace temperatures, which impose more severe conditions on the brick.

Frictional Resistance and Flexibility Of Seamless-Tube Fittings

A DISCUSSION of the relative friction loss in elbows and bends of different radii, and the relative flexibility of pipe lines made up with long-radius beds, cast fittings and seamless-tube fittings, was contained in a paper by Sabin Crocker and Arthur McCutchon, both of the engineering division of the Detroit Edison Company. The seamless tube fittings discussed are ready-made elbows and returns, forged from seamless tubing. These have been developed because of the increasing application of fusion welding to the erection of steel pipe lines. The fittings have a radius of 1½ pipe diameters.

It has been quite generally believed that an appreciably greater pressure drop results from short radius bends than from long radius bends. References and data from leading authorities were presented which show that very good results are obtained with a radius of 1½ pipe diameters and that practically no further decrease in frictional resistance is gained by making the radius of curvature greater than twice the diameter of the pipe. No data on a miter-type welded joint were presented; the closest approach to it was a pipe bend having a radius of ½ pipe diameters. The friction loss in such a pipe was shown to be from eleven to twelve times that of a bend of 1½ pipe diameters.

In comparing the merits of different piping layouts applicable to any given job, the question frequently is raised as to whether long-radius pipe bends, or so-called square bends, give greater flexibility. In making such a comparison it is necessary to consider both major phases of flexibility, the relative reaction set-up at anchor points and the maximum stress produced at any point in the bend or pipe line. The maximum bending moment produced at any point is also of interest, since the amount of bending moment obtained has a bearing on the probability of leaks in joints. A comparison of reactions and stresses for 90 deg. bends having a radius of curvature varying from 1 to 6 pipe diameters, and including a square bend has been made. Resulting data of this comparison were tabulated, and indicates that the lowest reaction force is secured with a pipe bend having a 1½ pipe diameter radius. It has the lowest bending moment, but the stress is relatively high.

A second comparison was made between an expansion U-bend formed by arcs having a radius of 6 pipe diameters, and various similar square expansion bends using 1½ pipe diameter radius bends and straight pipe. A comparison of the double-offset expansion U-bend was also made with square bends. Both these comparisons, indicated that the flexibility of the square bend, in regard to end reactions, is about twice that of the U-bend. In the case where the square bend occupies the same space as the U-bend, the maximum longitudinal stress in the U-bend is less by 35 per cent than the maximum stress of the square bend. In order that the magnitude of the bending moment at the top of the square bend may not exceed that which is found in expansion U-bend, two methods of procedure may be followed. If it is necessary or desirable to maintain the same width as occupied by the U-bend, an increase in height of bend by approximately 45 per cent will result in lowering the bending moment at the top of the bend to a value equivalent to that on the end joint of the expansion U-bend. The stress in the curved part of the square bend will be slightly less in the case of the higher bend than in the expansion U-bend, while the reaction forces at the end of the line will be only one-third as large.

A more efficient distribution of piping, as regards total length of pipe involved and resulting flexibility, may be obtained by increasing the width of the bend. The maximum flexibility in a given piping layout exists when every portion of a line is subjected to the same bending moment. In a symmetrical straight-line bend an ideal distribution of pipe is obtained when the length of straight pipe at the top of the bend is equal to the sum of the lengths of straight pipe at each end of the bend.

In the discussion of the paper, attention was drawn to the work of L. Wirt on pressure losses in various kinds of right angle bends. This work disclosed that a bend having a square outside surface and a rounded inside surface has less friction loss than the normal 90-deg. bend of equal center-line radius.

The friction loss in a bend having a radius of 5 pipe diameters varies between 80 and 40 per cent of the friction loss of a bend having a radius of 1½ pipe diameters, depending upon the author of the data used. Where space permits it was suggested that this decrease in friction was worth while.

It was pointed out that no comparison had been made between a square bend made up of welded seamless-tube fittings and straight pipe, and a similar bend made up of flanged cast-steel fittings and straight pipe. The difference between these were claimed to be 5 per cent.

The so called "center-of-gravity" method of calculating pipe stress and flexibility was suggested as being simpler than the method employed by the author. It was pointed out that no account had been taken of the initial elipticity existing in the expansion U-bend and that the difference in strength of cast-steel fitting and seamless-steel tubing had been neglected. Had the latter been considered, a greater deflection for the cast steel fitting would have resulted.

Larger Units Feature Ninth National Power Show

NOTWITHSTANDING the absence of some exhibitors of former years, the ninth annual power show held at the Grand Central Palace, New York City, Dec. 1 to 6, contained much of interest to the visiting engineers and was notable for the showing of larger and heavier pieces of equipment, some of them operating. It is becoming more generally appreciated by manufacturers that this is one of the best ways of placing before engineers the merits and operating characteristics of their products. With upwards of 400 exhibitors the show presented a good picture of the latest developments in power plant equipment.

The number of new products introduced for the first time was about the same as in other years. Most of the new products exhibited have been described previously in *Power;* others will be described in early numbers.

The extent to which the showing of commercial size units was carried out this year may be gleaned from a brief review of some of the larger units, outstanding among which was the exhibit of a large manufacturer of multiple-retort underfeed stokers. Here two complete retorts of a 15-retort unit (a duplicate of the installation at Delray No. 3) were in mechanical operation. Convenient stairways made it possible to inspect every working part of the unit. The retorts, erected complete with portions of water-cooled side and front walls, were driven by a standard fluid-motor unit through a two-speed gear box. The retorts were 57 tuyères long and equipped with six auxiliary pushers operated through the improved actuating mechanism that gives individual control of each pusher from the front.

Another large commercial size unit was a double-inlet induced-draft fan designed to handle 96,500 cu.ft. of 415-deg. gas per minute, at a static pressure of 8.6 in. water gage. The fan was one of a number being built for the Hershey Chocolate Company, Hershey, Pa. A second fan manufacturer included in his exhibit a double-width, double-inlet, induced-draft wheel, 8 ft. 3½ in. in diameter, designed for use with a pulverized-coal-burning boiler for producing 495,000 lb. of steam an hour at the Waukegan Power Station. The wheel will be direct connected to a 900-hp. motor operating at 695 r.p.m. Other combustion units included a 6,000 lb. per hour pulverizer, two large capacity, short-flame burners, and a single-retort stoker.

Another manufacturer of pulverized-fuel equipment featured the grinding element of an improved type of mill in which the weight of the grinding element is carried on the grinding rings and not on the shaft. Two rows of grinding balls are used, and the pressure

between the balls and the ring is regulated by external springs. A 40-ton pulverizer of this type driven by a direct-connected 500-hp. vertical synchronous motor is now being erected at the Kips Bay plant of the New York Steam Corporation. This is said to be the first installation of a pulverizer driven by a synchronous motor.

Fusion-Welded Drums

ELECTRIC fusion welding processes in the manufacture of high-pressure vessels were represented by the showing of three high-pressure drums on which the joints had been made by this process. One of the drums, a 48-in., on which both longitudinal and girth seams were fusion welded, had been given a destruction test, the bursting pressure being 3,250 lb. Another drum, 68 in. in diameter and 8 ft. long on the straight. without longitudinal seam but with two fusion-welded head seams, shown by the same manufacturer, is also to be given a destruction test following the show. The third drum was included in the exhibit of one of the larger boiler manufacturers. It was 48 in. in diameter, with fusion-welded heads. This drum had been tested to 3,250 lb. hydrostatic pressure and had taken an ellipitical shape, the diameter increasing in the straight part 13½ per cent. The heads had pushed out 3½ in., demonstrating the shape bumped heads tend to take when the metal is stretched beyond the elastic limit. This same boiler manufacturer showed a 54-in. hot-processed drum head being used on the 24,450-sq.ft. boilers now under construction for the Brooklyn Edison Company.

In the gas-welding field one of the larger manufacturers of welding gases and equipment demonstrated a portable tensile-testing machine designed to facilitate the testing of welds in the field or shop. The machine consists of a tubular compression member with a set of grips in the head and a hydraulic cylinder block in its base. A coupon cut from the work to be tested is placed in the grips, and hydraulic pressure sufficient to break the coupon is applied by means of a pump.

Prime Movers

IN THE LINE of prime movers shown at the show, was a small non-condensing steam turbine and five internal-combustion engines. The steam turbine, a single-stage machine, was designed for driving auxiliaries operating, in general, at speeds between 1,750 and 3,600 r.p.m. The internal-combustion engines included a 145-hp., a 245- and a 425-hp. gasoline engine used extensively for stand-by generating and pumping service in power plants; a 20-kw. direct-connected diesel-generator set; and a new six-cylinder (9x11-in.) diesel rated at 50 hp. per cylinder. The latter unit, the weight of which is given as 35 lb. per horsepower, is fitted with Bosch fuel pump and injection nozzles.

Considerable development work has been done during the past year on water columns and water gages for high-pressure service. Loose window construction featured one of the high-pressure gages exhibited. The flat glass is loose, acting only as a support for a thin mica strip which is clamped between flanges at each side of the water and steam column forming the central member of the gage mounting. In another type of gage, glass is eliminated entirely, mica only being used. The manufacturer of this particular gage exhibited also a double water gage designed for the new high-pressure locomotives now being built for the Canadian Pacific Railway and the New York Central Railroad. These locomotives will operate with two pressures on the drums, one 1,700 lb. and the other 850 lb. per square inch. Other types using an inclined water glass and with improved features that permit the use of the tubular glasses on pressures up to 650 lb. were also shown.

Instruments

INSTRUMENTS play a vital part in the operation of any power plant, and the trend toward high pressures has necessitated new developments in this field, a number of which were to be found at the show. Flow-meter bodies suitable for working pressures up to 5,000 lb. are now available. Heavy seamless open-hearth tubing is used for the pressure chambers, while the flanges and top caps are made from solid blocks of rolled steel. A decided advance in pyrometer design made by one manufacturer is in the replacing of the usual relay and auxiliary control equipment by a self-contained mercury contactor switch having a current capacity of 50 amp. at 220 volts or 60 amp. at 110 volts. This switch is inclosed within the instrument case. Another manufacturer showed a flush-type pyrometer in which the movement is so mounted that it can be swung entirely free from the case for inspection and repair without the necessity of disconnecting it entirely from the case.

Other new instruments included a recording vacuum gage with a barometric-pressure element, the vacuum and barometric pressure being recorded on one chart, and a multiple-strip chart recorder which produces any number of records up to six on one chart. These records may be any combinations of flow, temperature, pressures, etc.; a 34-tube draft gage for use with the improved type of forced-draft underfeed stoker, which is equipped with a series of Venturi nozzles in a common windbox. By means of this gage the air pressure over the entire grate surface is indicated.

One of the troubles encountered with certain types of draft gages is the drawing out of the oil under draft in excess of the scale range. A little device known as a check seal and designed to overcome this trouble was shown by one gage manufacturer.

An illustration of the many uses to which the Selsyn motor can be applied was demonstrated by a line of instruments for remote indication and record of pressure, draft, liquid level, etc., to which this type of motor has been applied. The most interesting of this group was a power-type Selsyn pressure transmitter operating a 36-in. double-face indicator. One or more

indicators or recorders can be operated by a single transmitter and they can be located practically any distance from it.

Much interest was shown in a new type of smoke recorder consisting of a tube about 3 ft. long having a light at one end and a thermopile at the other. The heat rays from the lamp are concentrated at the thermopile end by means of a convex lense. Between the lamp and thermopile smoke is drawn through the tube by an aspirator, the density of the smoke, by its effect on the amount of heat transmitted from the lamp to the thermopile, being recorded on a standard graphic instrument.

Centrifugal Refrigeration

ESPECIALLY INTERESTING to refrigerating engineers who visited the show was a 25-ton centrifugal refrigerating machine especially adapted to air conditioning and other services where a small capacity machine can be used. The different parts of the machine are combined to form a compact unit requiring comparatively small space. The condenser is mounted above the cooler, with the totally inclosed motor-driven centrifugal compressor and other auxiliaries mounted at the side.

Another new development in the refrigerating field was a unit cooler designed for use with direct-expansion ammonia, brine and other refrigerants and intended to take the place of the conventional pipe coil system used in storage boxes and other rooms where refrigeration is required. This unit, which occupies a rather small space, is said to replace 500 lineal feet of the standard pipe coil.

Among the high-pressure valves exhibited were a check and gate valve for 1,800 lb. working steam pressure and above 800 deg. temp. These valves were two of a number being supplied for the new high-pressure power plant of the Philip Carey Company at Lockland, Ohio. What is said to be the largest valve yet made for use on steam lines at 1,350 lb. pressure and 1,000 deg. temperature was shown by another company. This valve, a 14-in. gate, was made of chrome-tungsten steel having a tensile strength of 125,000 lb. A special line of fittings of the same material is also being produced.

Operating valves by pushing a button has been general practice for a number of years. A new innovation in valve control was introduced at the show. By use of a vacuum-tube control, a valve was made to open and close in response to the human voice. A valve control (De Florez) which makes possible the manual operation of a valve from a remote point was another type of control shown for the first time. With this device the actual work of opening or closing the valve is done by the operator in the control room or other point distant from the valve, the power or work being transmitted between the two points by Seslyn motors.

A multi-stage type of valve, a design introduced to the field since the last power show, was exhibited. In this valve the principle of multi-stage expansion is employed to give a relatively low flow velocity through the valve and thus reduce the effects of wire-drawing to a minimum.

In flow control valves in which a balanced disk is used with the inlet pressure admitted to the center of the disk, considerable side thrust is exerted on the disk during periods of high flow. A new valve designed to overcome this trouble was shown. In it the inlet pressure is made to diverge into twin ports, one at each side, at right angles to the direction of flow. By this design the pressure velocity is balanced when coming into contact with the disk.

One of the largest units at the show of interest to heating and ventilating engineers was a 5,000-c.f.m. air-conditioning unit. In this new unit the usual noise set up by the air fan and sprays has been reduced to a minimum by insulating the walls of the machine and admitting the air to the machine through narrow vertical passages formed by a cellular material. With noise eliminated, the unit can be placed in the room to be conditioned, thus saving the expense of connecting ducts. Other new products of interest to heating engineers were thermostatically operated radiator valves, automatic water feeders intended to protect heating boilers against low water and various types of controls for oil burners and unit heaters.

Improved Ash Pump

OF PARTICULAR INTEREST in coal and ash-handling equipment field was a hydro-vacuum system for handling fly ash and siftings from the last pass of boiler setting, economizers, air heaters, etc. With this system the dust and soot are removed in a dry condition through an air-swept valve bolted to the bottom of the ash-collecting hopper. The vacuum necessary to draw the air and siftings through the line is produced by a hydraulic ejector. An improved type of ash pump for use with hydraulic ash-handling systems was also shown by the same manufacturer. In this pump the main impeller, which is of the closed type, has clear-water vanes on each outside surface. The vanes are used to force clear water through the clearance spaces at the periphery of the impeller to the main volute of the pump. By passing clear water through these spaces, ash and abrasive particles are excluded and the clearance can be maintained at a minimum.

Electrical Equipment

ELECTRICITY always has an important place in the Power Show. Not only does it provide the general illumination and is used in many spectacular ways to attract attention to the exhibits, but it applies in some way to most of the equipment exhibited. As the latest thing in lighting, the Cologram was shown for the first time. Cologram is a method of coloring the walls of a room with light so that colors and patterns may be changed continuously through the use of a series of covers and flutes concealing incandescent lamps. Power for the lamps is supplied by Thyratron vacuum tubes. A continuously running timing device changes

the voltage applied to the Thyratron grids to vary the voltage on the lamps. The control equipment can be adjusted to blend and control the lighting to produce any desired effect. Not only does this method control the voltage at the lamps more gradually than can be done with rheostats, but does it without the large power losses inherent in the old method.

Progress in Motor Design

In Motor Equipment, the feature in several exhibits was a totally inclosed, fan-cooled, squirrel-cage, alternating-current motor. The rotor and stator windings are totally inclosed and the internal air circulated by a fan on the rotor shaft inside the inclosing shell. Over the stator core is an external casing. A fan is used to blow air through the annular passage between the outer and inner casings to dissipate the heat from the windings. On some types of these motors the internal air is circulated through a radiator consisting of tubes, the ends of which are welded into the shell inclosing the motor's windings. In others, the inclosing shell has a corrugated surface. One of the remarkable features of these designs is that the motors have the same mounting dimensions as open types of equal capacity.

The use of anti-friction bearings on motors were very much in evidence, and where sleeve bearings were used they were of improved designs to keep oil in the bearing and dirt out. These improvements in motor bearings have done much to prevent winding failure because of oil getting on the insulation.

Capacitor-type single-phase motors are coming into use. Several were exhibited at the show. The motor is a simple polyphase squirrel-cage machine, and a capacitor is used to convert the single-phase line current into a polyphase current for the motor. This motor has the advantage of no moving contacts, it develops good starting characteristics and has a high power factor.

Protective Devices

Compactness and better protection of equipment were the features most evident in control equipment. One manufacturer exhibited a combination safety switch and an across-the-line magnetic starter with thermal overload all inclosed in a metal cabinet of about the dimensions that were formerly used for the safety switch alone. A new line of pressure and temperature control devices was shown, all mounted in standard knockout metal boxes so that they could readily be installed in conduit lines. Another new control was an oil-immersed combination safety switch and across-the-line starter.

A miniature switchboard equipment was demonstrated on which the meters and control switches for one machine or circuit required a space only 4 in. wide. This type of construction allows concentrating all control switches and essential meters within easy reach of an operator's desk. A switchboard of this type for a station does not occupy much more space than the control and meter panels, of the conventional type, required for one unit. Another manufacturer showed a new method of mounting air-break circuit breakers in steel cabinets along with the busbars and other switchboard equipment. This arrangement not only protects the breaker equipment but also the operator, and allows concentrating this equipment in much less space than usually required. The circuit breakers are mounted so that they can be easily and quickly removed from their inclosing cabinets for inspection and repair.

A supervisory control equipment was demonstrated that provides a means of remotely controlling and supervising a large variety of power apparatus over two-line wires similar to those used for telephone service. A number of remote-control stations may be operated on the same two wires. Switches can be closed and opened and an indication of their position obtained. Machines can be started and stopped and remote meter indications obtained.

A method of controlling the power demand of a system attracted considerable attention. With this device the peak load can be automatically maintained within predetermined limits by disconnecting equipment that can be shut down for a period without interfering with the production processes.

Power Transmission

Several new developments were shown in mechanical power transmission equipment. The tendency to obtain a compact motor and reduction gear unit was evidenced in the booths of three exhibitors, in a combination of motor and gear reduction designed as a unit. In some of the larger designs the gear is mounted directly on the motor, while in the fractional horsepower sizes the motor is mounted on the gear. New designs of variable-speed transmissions were shown. Two exhibitors had totally inclosed designs that previously were operated open. Means of applying remote control to this equipment was also in evidence. An interesting unit in one booth was a motor mounted on a variable-speed drive and connected to it by a silent chain. A clutch connected the variable-speed transmission to a reduction gear. This made four types of power transmission equipment between the motor and its load. The so-called electrical eye (light cell) is being used for many purposes. One manufacturer demonstrated its application as a means of controlling a friction clutch.

A new three-speed gear box for stoker drive was the feature of one booth. The gears in this drive may be shifted while under load to change the speed.

Roller-type chain was shown on high-speed applications at two booths. In one the chain was running at a speed of 4,100 ft. per minute and in another the pinion speed was 3,600 r.p.m. In general, these types of chains have been considered applicable to slow speeds only. Improvements in their design have, however, extended their applications to many new fields.

First Floating Power Plant In Operation

THE SS. "JACONA," first ship to be equipped as a floating power plant, with a generating capacity of 20,000 kw., was recently placed in service by the New England Public Service Company of Augusta, Me. It is tied in at Bucksport, where a large tidewater paper mill is in the course of construction. This mill will require about 20,000 hp., which will be supplied by the "Jacona" until the Wyman Dam plant at Bingham is completed.

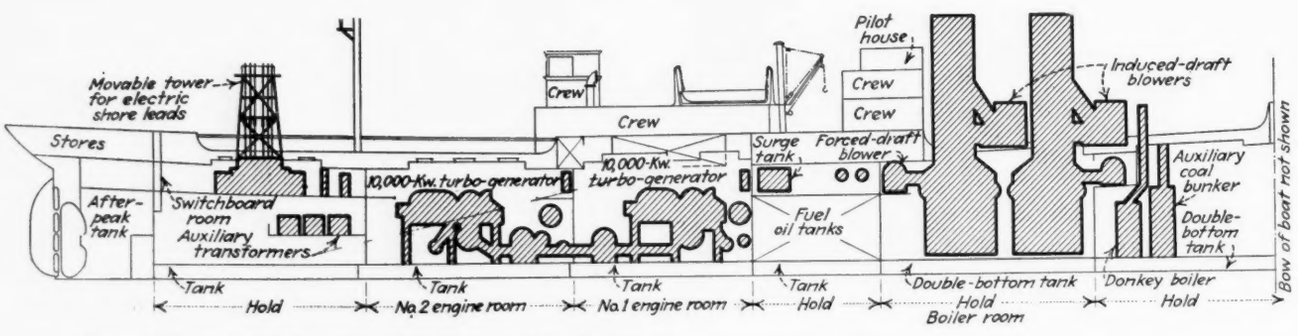
The New England company operates and controls 80 generating stations in Maine, New Hampshire and Vermont. A few of these are steam stations, but most of them are hydro-electric, and the company decided to add the floating power plant to its system to supplement emergency load demands, unusual drought conditions and other unforeseen contingencies. It purchased the "Jacona," a former single-screw, two-deck, three-island type cargo steamer of 5,128 gross tons, built in May, 1919, by the Todd Dry Dock & Construction Company of Tacoma, and placed a contract with the Newport News Shipbuilding & Drydock Company for its conversion into a floating power plant.

In order to accommodate the installation of new machinery, it was necessary to remove the main engine, boilers, and auxiliaries. The stack, foremast and four forward deck winches were also removed. The shaft alley, lineshaft, tailshaft and propeller were removed and the stern bearing was blanked by bolted plates outside and inside. A new watertight bulkhead was installed at the forward end of the tailshaft recess with a watertight door for access to the plate on the stern bearing.

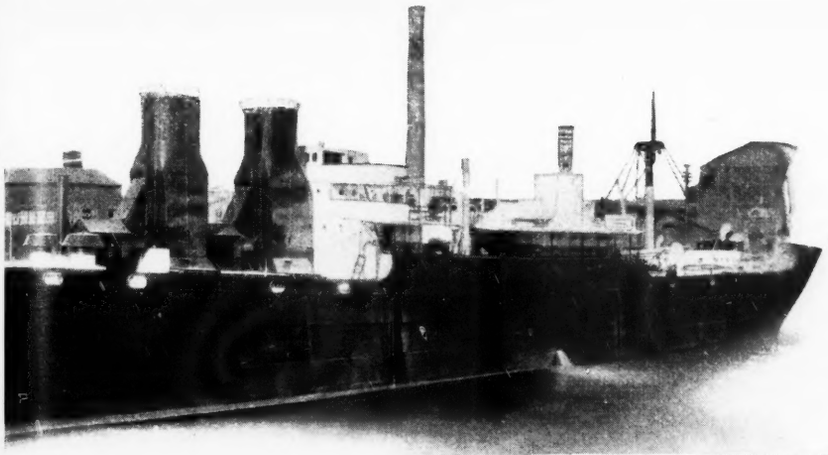
In the double bottom, stiffeners were fitted to receive the foundations for new machinery. The strongbacks in Nos. 1, 2 and 4 between deck hatches were removed and watertight doors were installed for access between the machinery spaces. New foundations were installed to accommodate the new equipment.

The maximum capacity of this plant is 20,000 kw. and consists of four boilers, which furnish steam for two turbine-generators, each rated at 10,000 kw. Practically all of the original cargo and machinery spaces are occupied by the new equipment. Near the forward end of the ship is a cargo space which is occupied by a donkey boiler and coal bunker. This boiler furnishes steam for heating purposes and for operating steam-driven auxiliaries, such as pumps and steering gear, when the ship is being towed. Aft of this is another cargo space that constitutes the boiler room. Here the second deck was practically removed to make room for the boilers, which extend to the main deck. In addition to the boilers, the following auxiliaries are installed in this space: Two motor-driven boiler-feed pumps, one turbine-driven boiler-feed pump, two fuel-oil service pumps, three fuel-oil heaters, one fuel-oil transfer pump, one bilge pump, besides numerous meters and gages.

The boiler equipment consists of four B. & W. marine-type boilers equipped with air preheaters, interdeck superheaters and soot blowers. These boilers deliver 280,000 lb. of steam per hour at 425 lb. pressure and 250 deg. F. superheat. Each boiler is equipped with eleven B. & W. Cuyama burners. The fuel oil is supplied to the burners at approximately 300 lb. pressure and 300 deg. tem-



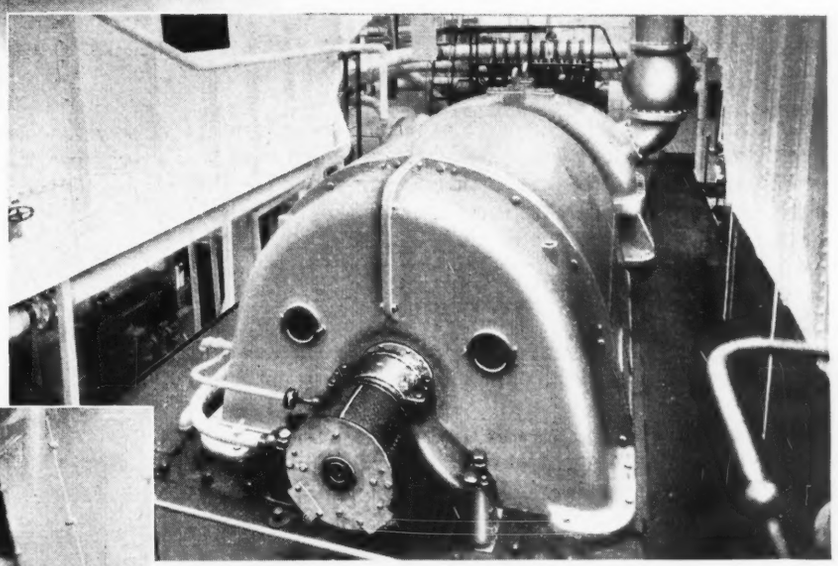
Layout of power plant equipment in hold of ship, showing arrangement of boilers, turbine-generators and control apparatus



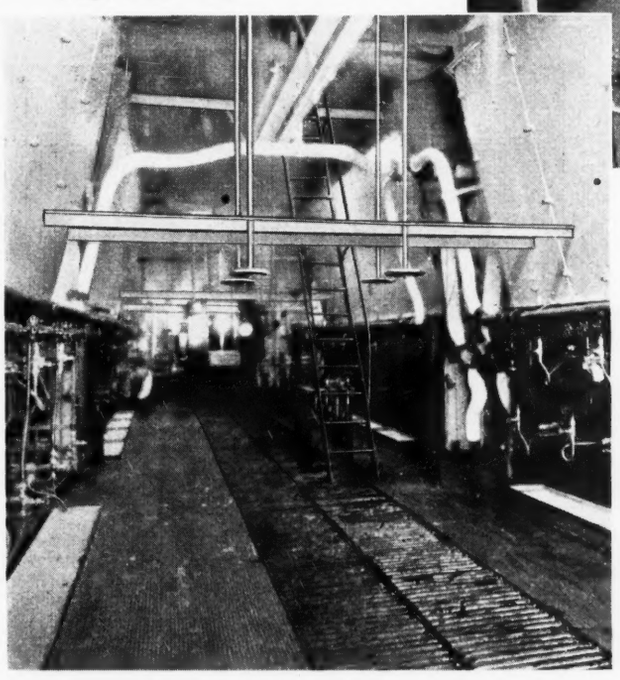
a total capacity of approximately 900 tone of fuel oil, or enough to supply the plant for five days at full capacity. The tanks have been reconditioned and fitted up with all necessary equipment for measuring and heating oil.

On the second deck level over the fuel tanks are two high-pressure feed-water heaters. A surge tank, which is in the boiler-feed suction line, is also located in this space.

Aft of the oil tanks is the old boiler and engine room. The dividing bulkhead has been removed, and this entire space is occupied by one of the 10,000-kw. turbine-generator sets with its auxiliaries. Next comes a cargo space, which is occupied by the second 10,000-kw. turbine-generator set with its auxiliaries. Following is another cargo space, near the stern of the ship, which constitutes the switchboard room. Switching equipment is located on the second deck and a bank of station service transformers is mounted below.



One of the two 10,000-kw. turbine-generator sets, which operate at 3,600 r.p.m. on 400 lb. steam pressure and 250 deg. superheat



Four oil-fired boilers equipped with air preheaters, interdeck superheaters and soot blowers are installed in this shipshape boiler room

The turbines are General Electric machines of the latest design and of high efficiency. They operate at 3,600 r. p. m. on 400 lb. steam pressure and 250 deg. superheat, exhausting into a Westinghouse surface condenser at 1 in. back pressure. With these conditions, steam consumption of the turbine alone is approximately 9.4 lb. per kilowatt at full load.

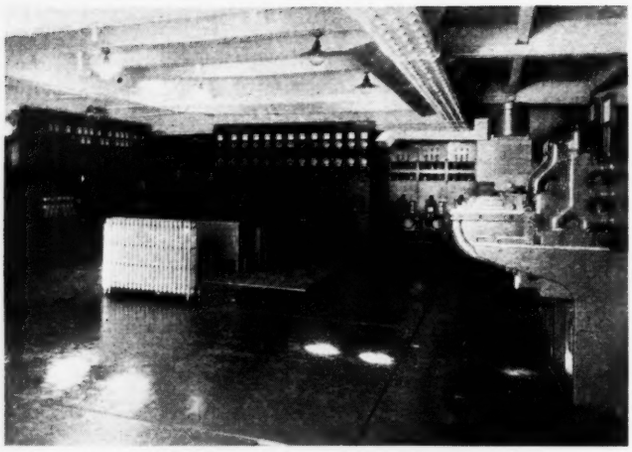
These turbines are directly connected to the generators, which have a closed system of ventilation. Cooling water for the air coolers and lubricating oil coolers is supplied by the main circulating-water pump.

The condensers are of the single-pass type, the tubes expanded at both ends. Each condenser is under the turbine which it serves and is suspended from the turbine exhaust flange. The main circulating water is taken from a tunnel extending athwartship so that water may be taken in from either side of the ship.

The closed feed-water system has been adopted. Distilled water will normally be used for make-up feed, thus avoiding deposits of scale in the boilers. Raw fresh water is passed through a deaërator before it is fed to

perature. Auxiliary steam is taken from two of the boilers through desuperheating coils. This steam is used for heating the fuel oil and for operating the steam-driven auxiliaries. The furnace walls consist of a high-grade firebrick and special insulation. There is one stack, one forced-draft fan and one induced-draft fan for each pair of boilers. The fans are equipped with variable-speed alternating-current motors, which are controlled from the boiler room floor. The boiler plant is designed to operate at high efficiency.

Near the center of the ship, between the boiler and engine rooms, are four built-in steel fuel-oil tanks with



The switchboard room shows a neat and convenient arrangement of equipment

the evaporators. The vapor from the evaporators heats feed water in high-pressure feed heaters which thus become distillers. The surge tank is steam-sealed, so that once the make-up feed has been deaërated no boiler feed water comes in contact with air. In case of emergency salt water can be used for evaporator feed in place of raw fresh water.

The turbines are bled from the fourth, seventh and tenth stages. Tenth-stage extraction at 7 lb. abs. is bled to the low-pressure heater, and the seventh stage at 26 lb. abs. is bled to the high-pressure heater. Fourth-stage steam, at 65 lb., goes to the evaporator.

With the exception of a few auxiliaries, the plant is divided into two separate units. Two boilers are arranged to serve each turbine, each unit having an evaporator, low-pressure heater, high-pressure heater and boiler-feed pump, with an auxiliary boiler-feed pump so arranged as to serve either system.

The generators are built for either 11,000 volts "Y" or 6,600 volts delta. Leads are brought out from each winding and carried to the oil circuit breaker units, where the changeover can be made from 11,000 volts to 6,600 volts, or vice versa, through a plug-type carriage. The switchboard equipment is treated for marine installation.

Most of the auxiliaries are motor-driven, but there are enough steam-driven units to enable the station to start up if there should be a break in the transmission lines and it should become necessary to start the plant without assistance from shore current.

The ship is provided with double-bottom tanks for oil and water storage, but these tanks will not be used at present, as there is no demand for them. The forward and after peak tanks, however, are connected up for service, principally to maintain the trim of the vessel. The bilge, ballast and oil transfer systems have been reconditioned to suit the new arrangement and are similar to those in other ships.

The crew's quarters forward and aft have not been disturbed, but the midship quarters have been reconditioned to accommodate fifteen to twenty men when the ship is being towed. The foremast has been unshipped to provide room for the boiler stacks, and the mainmast, which is fully equipped, has been kept in place to assist in handling equipment.

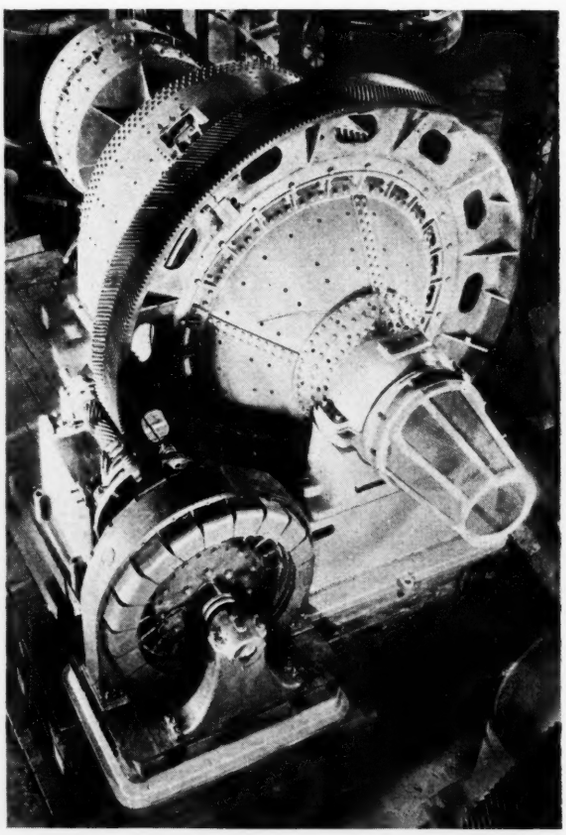
The method of making electrical connections to the shore was a problem involving considerable study. The arrangement finally decided upon consists of a steel tower on the dock and one on the port side of the ship, built on the main deck about in line with the center of the switchboard room. Arrangement has been made to transfer this tower to the opposite side whenever necessary. Two separate three-phase circuits consisting of heavily armored and insulated cable will run up these towers and over a barrel cross arm structure to the dock tower. A considerable amount of slack will be left in the cable between these towers to compensate for the rise and fall of the tide, which normally is about 10 ft. but at times of severe storm may go as high as 18 ft.

As the ship has no propelling equipment, it will be necessary to tow it from place to place as the occasion demands, and water, oil and electrical connections made to existing facilities ashore.

The whole is really a stationary plant placed inside a ship and combined with many marine features. Being the first plant of its kind, there naturally were many problems to work out. However, the installation is thoroughly modern and highly efficient in every way.

The conversion of the SS Jacona into a floating power house illustrates the adaptability of ships for this type of plant and is a credit to those whose pioneering foresight has made this idea a reality.

Synchronous Motor Drives Ball Mill



THE HARDINGE ball mill for installation by the Hudson's Bay Mining & Smelting Company, Ltd., at Flin Flon, Manitoba, Canada's largest mining operation to go into service at one time, is driven by a 400-hp. Canadian General Electric synchronous motor through a herringbone gear reduction

Hot Semi-Coke as Boiler Fuel

Production of semi-coke and gas by the Reed-Lamie process of low-temperature distillation is effected in a revolving retort divided into a series of chambers by transverse screens. Loose masses of angular and spherical shapes in these chambers transmit heat to the distilling mass and keep the walls of the retort and themselves free of carbon

DIRECT FIRING of a boiler by hot semi-coke in suspended form is one of the aims of the Reed-Lamie process for the low-temperature carbonization of high-volatile coal as devised by Harry S. Reed, associate professor of chemistry, Michigan State College, and Ralph W. Lamie, vice-president of the Universal Process Company, Detroit. The process is now being carried out on a pilot plant in Detroit. One of the objects is to conserve the sensible heat contained in the semi-coke and take advantage of the ease with which the hot semi-coke will flash into flame.

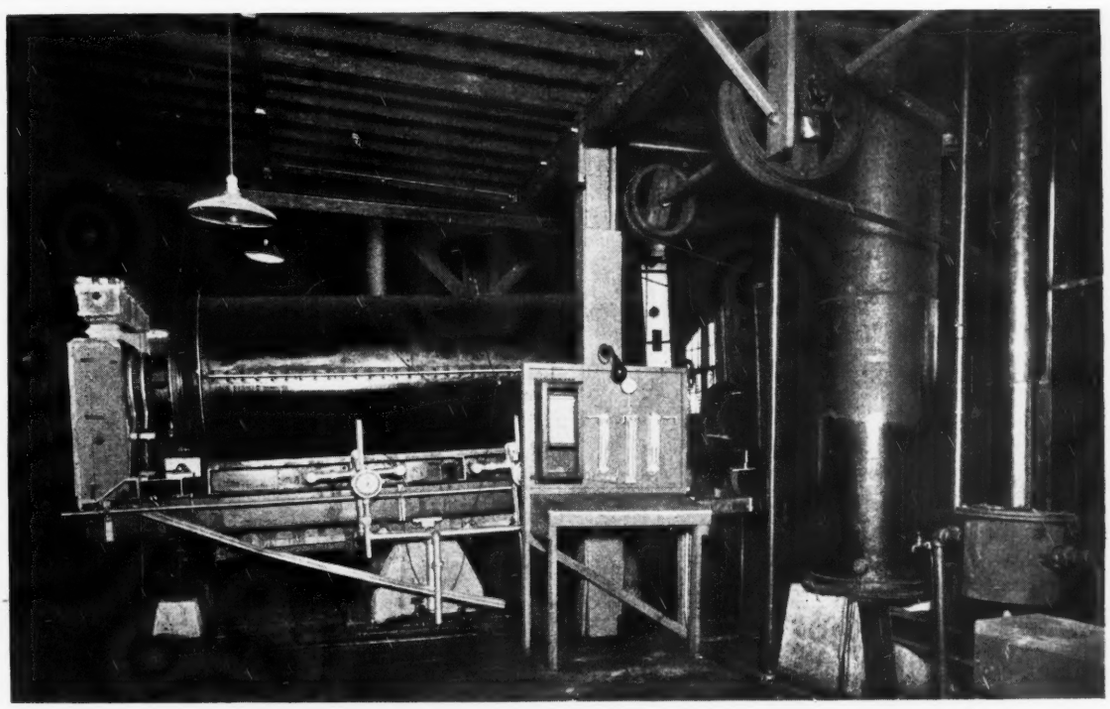
From a mechanical standpoint the process is comparatively simple. A revolving retort is used, which is kept gas tight by specially designed seals. Slack coal, which may or may not be preheated, is fed into the revolving retort by a screw feeder.

The interior of the retort is divided into a series of chambers by transverse screens or grids. Within each of these chambers is placed a loose mass of impact bodies, some of which are spherical and some angular. The size, weight and proportion of angular to spherical shapes of these bodies are not the same in all chambers, but are selected according to the work which they are required to do, their main functions being to transmit heat to the distilling mass and to keep the walls of the retort and themselves free of carbon. The screens or grids distribute the load of impact bodies within the retort as desired. The last screen on the discharge end functions as a separator for the pulverized semi-coke.

Discharge of the coke from the distillation chamber is accomplished by a simple plough, which revolves with the retort and lifts the semi-coke from the periphery to the center, where, by means of a helical screw, it is passed through the discharge pipe into a combined hopper and dust chamber. This hopper is maintained gas-tight by a counter-weighted bell, which, when the load builds up, opens sufficiently to allow a stream of semi-coke to flow out, according to the amount coming into the chamber.

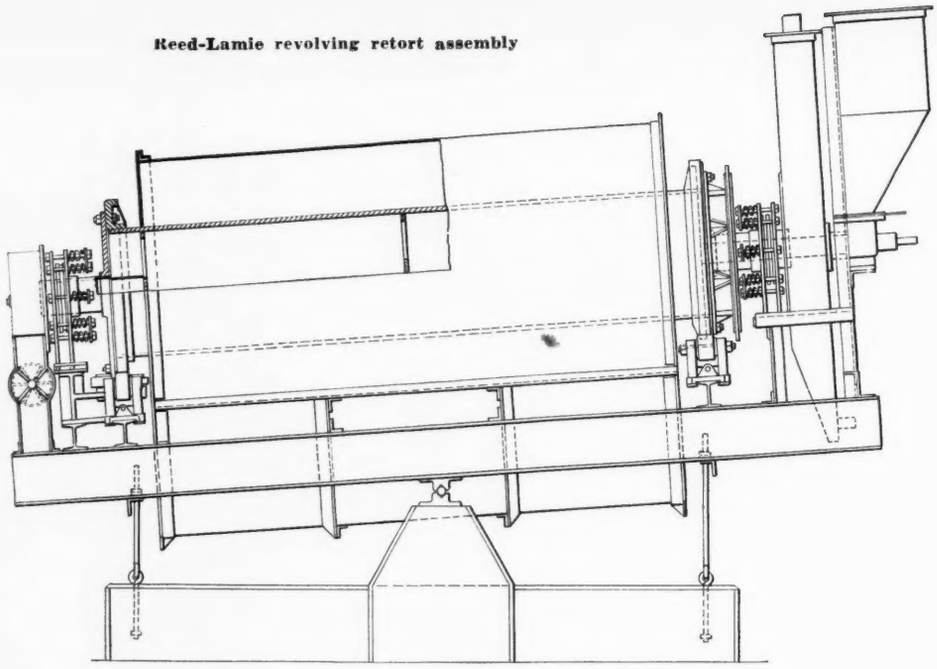
At this point it may be well to remark upon the mobility of hot, powdered semi-coke. The angle of repose is slight and the coke will flow freely; therefore there is no arching, as with pulverized raw coal, and no difficulty in discharging it out of the retort.

The gas seals at each end of the retort consist of two special alloy composition rings forming a tight sliding



Pilot experimental plant in Detroit using Reed-Lamie revolving retort and standard equipment for byproduct recovery

Reed-Lamie revolving retort assembly



bearing on the two sides of a collar fastened to and revolving with the intake and discharge sleeves. The sealing force is largely the expansive force of the retort operating against two flexible diaphragms. To relieve these thin metal disks of torsional stresses, the collars to which they are attached have legs that rest on a solid base, which is so arranged as to allow a free end-to-end motion but no rotational movement.

Byproduct Recovery

Byproduct recovery is effected by coolers, scrubbers and a gas pump. The tar produced is of the typical low-temperature character showing a fairly high fraction boiling within the gasoline range. This fraction, which ordinarily would correspond to the light oil fraction from high-temperature tar, differs considerably from its older prototype by consisting almost entirely of alyphatic hydrocarbons. Benzol and other cyclic hydrocarbons, if present, are in small amounts only; nevertheless, this fraction, when tested in a standard detonating engine, shows a 100 per cent benzol equivalent, and is thus useful as a blending material for the production of an anti-knock motor fuel.

RESULTS FROM TEST RUN ON W. VA. NUT AND SLACK COAL

Moisture, per cent	1.80
Volatile matter, per cent	34.14
Fixed carbon, per cent	54.76
Ash, per cent	11.10
Sulphur, per cent	1.36
B.t.u.	13,327

RECOVERIES PER TON

Tar (dry), gal.	27.54
Gas, cu.ft.	4,200
Semi-coke, lb.	1,420

ADDITIONAL DATA

B.t.u. of gas produced	870
Volatile in semi-coke, per cent	9.61
Rate of coal fed per hour, lb	500
Gas consumption per hour, cu.ft.	1,130
B.t.u. of fuel gas	520
B.t.u. per lb. of coal distilled	1,175
Per cent of B.t.u. in coal necessary to distill	8.82
Estimated stack losses and other recoverable heat, per cent	2½

The next higher boiling fraction contains the low-boiling phenols and a neutral oil. The phenols consist largely of cresylic acid, only a small amount of carbolic acid being present. The next fractions between the low-boiling phenol range and soft pitch contains the higher boiling phenols and neutral oil. The neutral oils from these two fractions can be used only as fuel oil. However, it has been shown by Egloff and Morrell that the entire tar can be cracked by known methods to produce a motor fuel with high anti-knock characteristics.

Gas produced by the process has a high heat value ranging from 850 to 900 B.t.u. per cubic foot. A portion of the gas produced may be employed to heat the retort and the balance sold locally, to be used in a mixture with water gas to obtain the correct quality for domestic distribution.

In the accompanying table results are given from a test run on West Virginia nut and slack coals. Analysis of the coal is given and supplemented by tar, gas and semi-coke recoveries and additional data that will be of interest. It should be pointed out that the gas was not scrubbed for light oils and that the pilot plant is not equipped with recuperators.

Difference in Salt Content of Sea Water Seen as Power Source

USE OF the difference in pressure between waters of of different salt content for power production, following the principle demonstrated by Georges Claude this fall, when he used the difference in temperature between surface and deep sea water to furnish electrical energy, has been suggested in a report to the French Academy of Sciences, according to the Paris correspondent of the American Chemical Society.

"At the mouth of rivers," the report explained, "a large volume of fresh water is found immediately in contact with a large volume of salt water, and it seems possible, by means of a suitable apparatus built on principles similar to those demonstrated by Georges Claude, to utilize the difference in vapor pressures."

...RIGHT OUT OF THE PLANT...

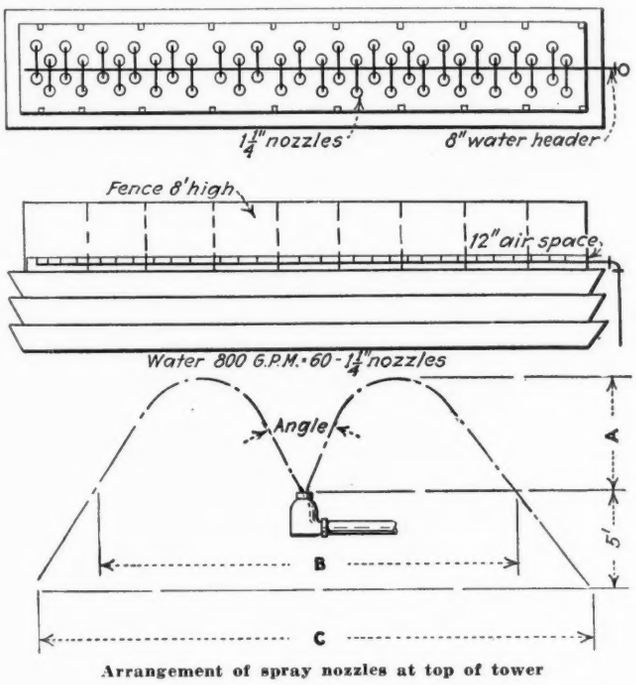
Use of Spray Nozzles Increases Capacity of Cooling Tower

SOMETIMES additional cooling from an existing tower is required. If the tower is of a standard make this can be obtained by adding more decks; however, even that will not, in all cases, give the required temperature change.

Also, if the tower is of the closed-louver type it is not always practicable to add more decks. Additional cooling is then obtained by using spray nozzles. The latter are available in various sizes and types, all of which have their special qualifications.

Having decided on the type, knowing the amount of water to be cooled and the pressures of the water from the circulating pump, the right number of nozzles can be determined. Performance data given in the accompanying table are for the type of nozzle with which I have had the most experience. It is, however, much the same as with other makes.

To install the nozzles, the top deck and distributing troughs are removed from the tower. A header of suitable size for the pump capacity is then run down the



Arrangement of spray nozzles at top of tower

center of the tower. From this header nipples are welded into it, one end being threaded to take the nozzle or a made-up header can be bought with screwed reducing fittings.

The nozzles are usually placed on alternately long and short nipples, arranged so that a complete curtain of water will be attained.

Having completed the header, a fence, usually about 8 ft. high, is erected all around the top of the tower and held in place by posts spliced to the existing tower posts, with brass or galvanized bolts. The sides are usually of redwood shiplap and should be of select clear

SPRAY NOZZLES DATA

Dia. Nozzle, In.	Pressure, Lb.	G.p.m.	A Feet	B Fee	C Feet	Angle Degrees
¾	10	6½	8	14	15	55
1	10	8	8	14	15	55
1¼	10	14	9	13	14	65
1½	12	27½	9	25	26	80
2	9	33½	9	23	24	70
2½	9	62½	9	22	23	70

wood free from knot holes. A door must be placed at the top of the stairway, also a runway so that access may readily be had to all nozzles.

By the addition of nozzles to an existing tower several degrees more cooling may be had and better results achieved than raising the tower by adding decks.

M. C. COCKSHOTT.

Long Beach, Calif.

The Future of Marine Steam Power

ALTHOUGH *Power* and the other technical land magazines refer to marine engineering affairs very infrequently, they do so upon occasion. In your issue of Oct. 21 you have commented editorially upon "The Future of Marine Steam Power," on page 635, and have made some mention of the new Cunarder, in relation thereto, on page 666.

In view of the fact that in your editorial you speak "offhand," to use your own expression, and rather at variance with well-established marine practice, as it were, and further in view of the fact that the meagre description of the Cunarder power plant is in error, I should appreciate your printing the following statements:

Although experiments are being conducted with pulverized coal for marine use, that form of fuel has found its only real application in Scotch boilers, which everyone knows are limited as to pressure, superheat and capacity. There are, however, 38 vessels afloat which use stokers under water-tube boilers. Probably the most successful such ship is the S. S. Carl D. Bradley, of 4,200 s.h.p. rating.

When one considers the fact that marine boiler fuel oil

of 18,500 B.t.u. per pound costs approximately $7 per ton delivered aboard ship, while good steaming coal of 14,250 B.t.u. per pound costs approximately $5.50 delivered, simple calculation soon demonstrates that there is no economic justification for using pulverized coal, since the use of such a fuel entails much higher boiler settings and far greater weight, in addition to greater weight and first cost of coal-pulverizing, firing and handling equipment. The large oil-burning steamers carry a considerable portion of their fuel in their double bottoms, and other spaces where coal could not be stored, and can bunker in a few hours without fuss or dirt, whereas coaling is a dirty process, and might delay sailing schedules.

Contrary to your statement, the Berengaria is not the highest-powered vessel afloat, by a long way, being exceeded by at least four vessels, the Leviathan (1914) and the Majestic after the war, both of which have direct-drive turbines which develop in excess of 80,000 s.h.p. on four shafts. Of more recent date, the Europa and Bremen, having geared turbines of 120,000 s.h.p. normal rating each on four shafts, have gone into service.

The new Cunarder, which will be rated at somewhere over 140,000 s.h.p. on four shafts, will employ geared turbine drive, having steam conditions in the neighborhood of 600 lb. gage boiler pressure, 700 deg. F. total temperature and high vacuum. Incidentally, if she is designed for 29 knots normal sea speed, it will be remarkable if she attains 32 knots, since the jump from 29 knots to 32 knots will require practically double the power.

You may be interested to know that the Japanese Navy has ships of 88,000, 96,000 and 132,500 normal s.h.p., respectively, which have operated with excellent records for upward of six years, using American-made gears.

While marine plants have not gone to steam pressures and temperatures as high as those used on shore, they have, in their own way, kept step with land practice, or even gone ahead of it. Due to the fact that weight and space considerations are so vital aboard a revenue-earning vessel, the use of economizers, air preheaters and multiple-stage feed heating can only be adopted to a limited extent, as compared with central station practice. So far, it appears that in large ships two-stage heating with air preheaters may be justified and pressures around 400 to 600 lb. with 650 deg. to 750 deg. total temperature may be employed without too great weight and complication in the exceedingly small engine room space available. As an example, an addition of 1,500,000 lb. engine room weight to the 1,000-ft. Cunarder would submerge her approximately 4 in. deeper in the water, which would then require 1,600 more s.h.p. to propel her at designed speed.

You may rest assured that the marine engineering world appreciates editorial mention of its progress in *Power* and hopes for continued, more accurate and intelligent comments in that well-established and widely read publication.

CARL J. LAMB,
Member Society of Naval Architects and Marine Engineers.

South Philadelphia, Pa.

[While *Power* gladly publishes this letter and acknowledges correction of the error in its news item, it should be pointed out that the remainder, although interesting, does not alter the broad facts originally stated in the editorial.—EDITOR.]

Setting Brushes on Interpole Machines

IT IS a common practice to change the speed of a direct-current motor by giving the brushes a backward or forward lead. Certain things must be borne in mind, however, where a motor is equipped with interpoles, otherwise the motor may become unstable in operation.

Because the position of the brushes may be moved ahead of or behind the neutral point a certain distance without producing sparking, there is a tendency to abuse this characteristic of the interpole machine. If the strength of the interpoles has been adjusted properly considerable shift of brushes may be made without affecting commutation. However, it should be remembered that the motor will not run at the same speed in both directions of rotation; nor will the commutation be as good in the one direction as in the other. Further, the motor may become unstable after the brush shift reaches a certain point.

It is easy to understand why this is. The polarity of the interpole in a motor is the same as the polarity of the preceding main pole. For that reason a backward lead of the brushes will cause the interpole flux to demagnetize the main field. An increase in load will then cause a weakening of the main field, with an increase in speed, resulting in the motor's becoming unstable if the demagnetization of the main field is carried too far.

The effect of changing the position of the brushes on a motor is opposite to that obtained on a generator. Moving the brushes backward on a generator increases the voltage, while a forward movement or lead of the brushes from the neutral decreases the voltage. On the other hand, moving the brushes forward on a motor causes it to slow down; while moving the brushes backward causes a motor to speed up, for a given direction of rotation. Generators operate best when the brushes are rocked forward; whereas motors operate best with the brushes rocked backward, because the flow of the current is in the opposite direction. R. K. LONG.

Chicago, Ill.

Damage Caused by Surges in Hydraulic Pipe Line

I WAS much interested in the article in the Nov. 4 number by Ralph E. MacKay, with reference to damage caused by surges in hydraulic pipe line.

A number of years ago I had occasion to view damage caused by a sticking check valve in the water discharge line from a jet condenser. The accompanying diagram shows the arrangement of condenser, discharge pumps and hotwell.

A jet condenser was used in this plant because the cooling water was very hard; in fact, considerable scale matter was precipitated at temperatures slightly above 100 deg. F. As is usually the case with such plants, there was also at times a shortage of water, necessitating operation of the condenser with cooling water discharge temperature as high as 130 degrees.

After the plant had been in operation about six months the unit was shut down one night. A second or so after

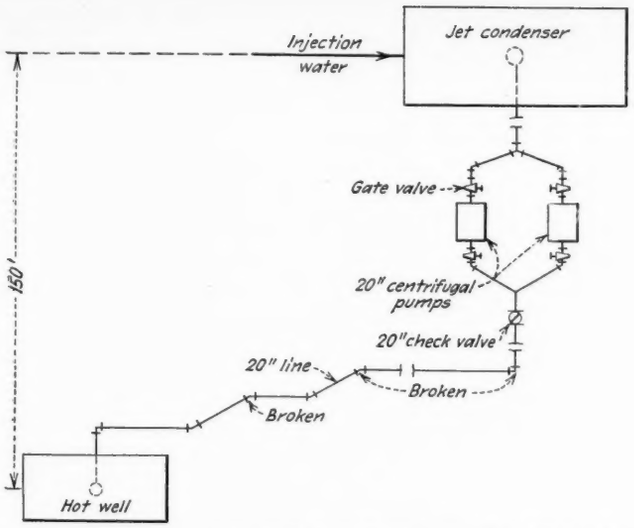


Diagram shows arrangement of condenser, pumps and hotwell

the centrifugal pump had stopped a violent surge took place in the discharge line, resulting in the breaking of several large fittings, as indicated in the illustration. Investigation disclosed that the interior of the check valve was covered with about half an inch of scale. When the pumps were stopped the check valve did not close immediately, the result being that the water in the hotwell started a reverse flow into the condenser. This flow had apparently assumed considerable proportions when its action closed the check valve. The result was the surge, which set up sufficient shock to break the fittings.

It is obvious that the operating crew inspected and cleaned the check valve each week-end thereafter. The plant operated several years with no further trouble.

Louisville, Ky. JOHN F. HURST.

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THE WRECKING of a centrifugal pump described by Mr. MacKay recalls some experiences with deepwell turbine pumps. It is customary to place a check valve at the discharge opening of a deepwell turbine pump. Occasionally, due to sand or various defects, the check valve may not close when the pump is shut down, in which case the pump will reverse and run as a turbine, the water passing back into the well and out into the ground through the well perforations. If the pump is discharging into a tank or reservoir at any great elevation the speed may be high enough to damage the motor. But the chief danger lies in the sudden closing of the defective check valve after the reverse flow of water has started. The resultant water-hammer may wreck the check valve and damage the pump head.

Another danger is that of automatically operated pumps that are started and stopped by float switches. Should a defective check valve cause an automatically controlled pump to reverse, and run thus until the water level dropped to the point that the starting switch functioned, the result would surely be disastrous to the motor and pump. The strain caused by the application of power when the motor and pump are turning at high speed in the reverse direction would at least twist off the drive shaft, and probably would wreck the motor. Some check valves are slow to act, therefore it is always good practice to install an air chamber between the check and the tank to absorb the shock caused by the sluggish action of the check. A. C. MCHUGH, *Chief Engineer,*

Norwalk, Calif. Norwalk State Hospital.

Combustion Recorders Are Boiler Room Necessities

DEVICES which now are regarded as necessities in power plants, both in the boiler room and in the engine room, once were looked upon as luxuries. The records of a century or more ago show that the steam gage and even the indispensable water gage of present-day boiler practice figured largely in this category. In more recent times the steam engine indicator was added to the list. And today the CO_2 recorder and the steam-flow air-flow combination are relegated to this same rank by many operating engineers whose experience should have taught them better.

What is the logic of spending time and labor on the task of indicating an engine and adjusting and readjusting the valves, to the end that high economy of steam distribution may be secured, when no adequate thought is given to the economy of steam generation. Getting the engine or turbine to perform with the least possible consumption of steam is a matter of abiding importance. But it is no more important than building up the efficiency of the boiler furnace and seeing that it is operated economically. Just as the indicator is indispensable in tuning up the engine to first-class service, so is the carbon-dioxide machine on the steam- and air-flow meter an accessory of prime importance in holding furnace losses to the lowest possible limit.

No argument is needed to prove the futility of trying to determine from visual evidence alone the degree of economy obtaining in the performance of a boiler furnace. But with the aid of either of these instruments the problem is easily solved, for it is possible to obtain definite information about the excess air that may be filtering into the furnace, combustion chamber and smoke uptake.

The full benefit of instruments in improving operation in the boiler room is realized best through the use of continuous records. Tests made or readings taken at intervals are of little value. This is so because the stoking activities may range from the attainable maximum of regularity and efficiency down to the point of gross negligence and back again many times during the course of a day's run. Only the continuous recorder can tell the story of performance throughout. A. J. DIXON.

St. Louis, Mo.

Safe Air Nozzle for Use on Electrical Equipment

THERE are some cases on record where men have been shocked while blowing off electrical equipment, and others where an air hose with a metal nozzle has been dropped accidentally into a rotating machine, considerable damage resulting.

To prevent both of these occurrences, in so far as possible, a mica bushing about 24 in. long and one-half inch diameter can be used. The bushings can be found in most any electrical shop where a resistor has been junked.

Danger of an electrical shock is greatly eliminated when a mica nozzle is used. In the event of its being accidentally dropped into a rotating machine the damage is much less than if it had been a metal nozzle.

Butte, Mont. RALPH E. MACKAY.

From Among Readers' Problems

Conducted by
L. H. MORRISON

ADJUSTABLE VALVE LIFT—*We have a 250-hp. air-injection diesel, connected to oil pumps. Ordinarily we run it at 160 r.p.m., with a needle opening of ¼ in. timed to open at 5½ deg. ahead of top dead center.*

Recently we ran at 70 r.p.m., due to excessive line pressure, with the same valve setting. At this setting and speed the compressor would not make enough air for injection, without supercharging the low-pressure stage from other sources. If the needle valve had been set to lift ⅛ in. instead of ¼ in. what effect would it have had on the timing and efficiency of the engine? Would it have been necessary to change the timing to still open at 5½ deg. F.?
H.E.Y.

Some diesel engines vary the needle valve lift with change in load, which gives some advantages not obtainable where the air pressure is lowered to save air at low loads. It may, however, prove difficult for one in the field to alter the needle-lifting mechanism to make it adjustable, as the adjustment should be under governor control.

The common method of reducing the injection-air pressure is recommended before timing alterations are made, if it is not the present practice to adjust this air pressure.

FEEDING TRISODIUM PHOSPHATE—*What would be the effect on the tubes of an inclosed feed-water heater, of feeding direct through the heater a solution of 9 lb. trisodium phosphate to 50 gal. water continually for 24 hr.? Would it be better to feed this solution in the boiler feed lines without putting through the heater? Would it cause the tubes to accumulate scale?* P.J.B.

There should be no ill effects from feeding into the heater. Care should be taken that the feed is continuous, to prevent overconcentration of the mixture and deposition of calcium phosphate in the tubes.

COMBUSTION OF COKE—*Has the size of the coke any influence on the rate of combustion?* J.U.

It has been found that with a given weight of coke the rate of combustion depends upon the weight of air that can enter into the reaction, and this weight of air depends upon the surface area of the coke particles. Consequently, combustion increases with a decrease in size of the individual coke lumps or particles.

PERMISSIBLE CALKING PITCH—*What is the maximum pitch for a 1-in. cover plate of a pressure tank that will permit calking?* C.C.

The maximum is about 5½ in., although for low-pressure work this pitch might be made a little greater.

ENGINE PUMP PLUNGER CUTS—*We operate a 50-hp., airless- or pump-injection Diesel. As long as we used fuel oil no pump trouble was experienced, but upon recently changing to a temporary use of kerosene, due to its availablility at a lower price, the plungers of the fuel pump have cut badly. Is the trouble with the fuel?* J.A.V.

Ordinary grades of fuel oil have some lubricating properties and, consequently the plungers were not in metallic contact with their bushings. Kerosene, on the other hand, is practically devoid of lubricating qualities, so the plunger soon scores the bushing. Unless the kerosene is considerably cheaper, which is seldom the case, it would be advisable to use a fuel oil of not higher than 36 deg. Baumé.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

IN our plant there is an an extensive system of 440-volt, 3-phase power conductor and 220 and 110 volt lighting circuits. Faults have occurred in the wiring that have been difficult to find. I would appreciate suggestions as to the best way of locating faults in a complicated wiring system and what may be done to find the weak spots before they develop into failure and cause unexpected trouble.
D.B.O.

THE CONDITION of the electrical network should be determined by making a through survey. Note lengths and sizes of conduit, and its condition. Ascertain the size and number of conductors in each conduit. Examine the insulation at all junction boxes and outlets. See that it is not worn through due to the conductor's weight, or otherwise damaged. Since conduit is often buried or otherwise concealed, it is difficult to understand the statement that some of the circuits are located in accessible places. However, the junction or pull boxes may be out of reach.

Find the maximum load in amperes, and its duration on each circuit, preferably by using a curve-drawing ammeter. Also ascertain the voltage drop in each circuit at maximum load. The voltage drop from the switchboard to any motor should not exceed 10 per cent; it should preferably be 5 per cent. The permissible voltage drop in the lighting mains is less than that which can be tolerated in the power circuits.

At the completion of this survey, during which as much pertinent data as possible should be collected, the insulation resistance of each conductor, circuit by circuit, with all control equipment disconnected, should be measured. If the insulation resistance of any one conductor is consistently less than 1,000,000 ohms it must be sectionalized and the defective section repaired or replaced. This method will eliminate the weak spots. Insulation resistances should be measured at least yearly.

If the existing conduit is large enough to accommodate the necessary conductors, replacement can be made with minimum inconvenience by bypass-

ing the defective section with a temporary circuit run outside the conduit. Should the existing conduit be too small new circuits of liberal size should be run, preferably in conduit. The load should be apportioned among the new and old circuits. New circuits should supply the most important equipment.

Ground detectors should be installed on each ungrounded system. Warnings given by these devices will often enable locating and clearing grounds before serious trouble develops.

Oakland, Calif. F. D. FORE.

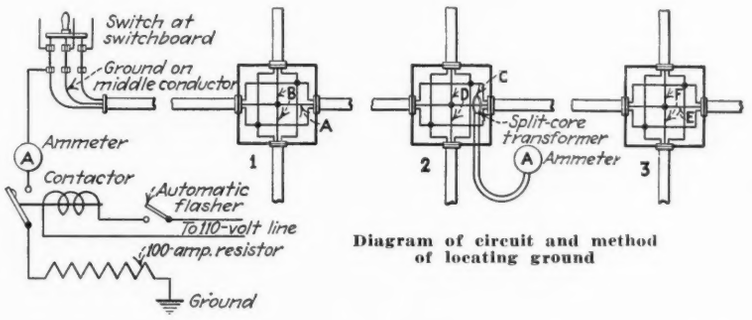


Diagram of circuit and method of locating ground

A GROUND on a complicated feeder system is sometimes difficult to locate without dividing the system into a number of sections. To find the feeder harboring the fault, open one switch at a time on the switchboard. When the faulty feeder is disconnected from the busbars the ground lamps will show clear. Where the feeder serves several branches from a number of junction boxes the exact location of the fault is frequently found by sectionalizing the circuit and testing each section for grounds. The following describes a method used in our plant for locating a ground on a 700,000-circ.-mil feeder without distrubing any of the connections.

The figure shows the general arrangement of the circuit. The ground was known to have low resistance, as a 225-hp. motor, requiring 400 amp., had been started through the fault without burning it clear. A rheostat that would carry about 100 amp. was made up of discarded resistors. One terminal of this rheostat was grounded and the other was connected to one of the ungrounded conductors at the switch, through a magnetic contactor. The contactor coil was connected through an ordinary lamp flasher to open and close the circuit at about three-second intervals. By opening and closing the contractor, intermittent current impulses were sent out through the grounded conductor. An ammeter was connected to the conductor in the junction boxes by a split-core current transformer, as shown.

In the figure the center conductor is assumed to be grounded. Assume that the fault is in the conduit between boxes 2 and 3. If the ammeter is connected to the faulty conductor at *A* in box 1 it will indicate the current impulses flowing into the ground fault. If the ammeter were connected into either of the branch feeders at *B* it would show only the normal current flowing in the circuit. In box 2, if the ammeter is connected as at *C* it will indicate the current impulses flowing to the ground, but if connected in the branch feeders as at *D* it will show only the load current in the conductors.

If the faults between boxes 2 and 3 and the ammeter is connected at *E* or *F*, in box 3, it will show only the load current in the conductors. This would indicate that the fault had been passed. As the fault was indicated in box 2 and not in 3, the conclusion is that the trouble is between the two. After the position of the fault is located the feeder may be taken out of service at a convenient time and the defective section replaced.

Alton, Ill. L. E. BENEZE.

A Question for Our Readers

THE LOAD on our plant reaches a maximum of 1,875 kw. and the capacity of the generating equipment is 3,750 kva. in three 1,250-kva. 550-volt, 80 per cent power factor generators. The power factor of the load is low, around 65 per cent. The load consists chiefly of induction motors ranging in size from 200-hp. down. It is desirable that the load be reduced or more spare generating capacity be provided. Apparently, reducing the load by improving the power factor would be the best solution to the problem. Would some readers of POWER *give me the benefit of their experience with methods of correcting power factor and the results obtained?* R.E.

Suitable answers from readers will be paid for and published in the Jan. 13, 1931 number

I SUGGEST that "M. D. B." obtain one of the several types of megohm meters on the market and make a careful survey of the insulation on the different circuits. For general circuit testing, I set a standard of one megohm, but wiring and equipment having a lower insulation resistance may be safe to operate. It is not so much what the insulation may be at any time, but how fast it changes. When the insulation resistance of equipment shows a continuous decrease at each test it is certainly on the road to failure.

Weather conditions, changes in temperatures and other factors have a tendency to change the insulation resistance; therefore when making periodic tests existing conditions must be taken into account. During wet periods the insulation of equipment and circuits will generally be lower than when a dry atmosphere exists. Heat is injurious to rubber, thereby reducing its insulation value. Overheating of cables may be caused by overloads due to low power factor, improperly laid-out feeder system, external heat due to conduit's being close to steam lines, and to other causes. Whatever the cause is it should be removed.

Circuits with exposed parts are subject to electrical equipment's greatest enemy—dirt. This includes all foreign substances, some of which are good conductors and others that become so under the influence of heat or moisture. I have found that one of the greatest sources of trouble encountered in conduit is that at the time of installation the ream was used too sparingly and burrs were left to injure the insulation of the wires or cables pulled into place. Another installation practice that causes trouble is the failure of the men to run a die over all threads before joining conduit together. The ideal job is obtained by butting the reamed ends of the conduit together in the coupling, thus making a smooth raceway for the wires.

Trouble is often found in connections and splices on conductors. Improperly wiped soldered joints are likely to pierce the insulation over them, thereby causing trouble that is hard to locate. The contact is generally so small that it is destroyed and the surrounding insulation is charred. This may not cause a short circuit again until sometime later, when it is likely to burn clean and leave very little or no external evidence of the cause. Conduit runs passing through regions having different temperatures are likely to collect moisture, because the warm air enters and is carried along to a cooler region, thus sweating up the inside of the line. If conduit runs act as ventilators, close them with insulating compound.

Volumes have been written regarding the planning, construction, testing and repairing of circuits in metal conduit, but each installation is a problem unto itself that must be worked out according to the dictates of conditions.

ANDREW W. OPPMANN.

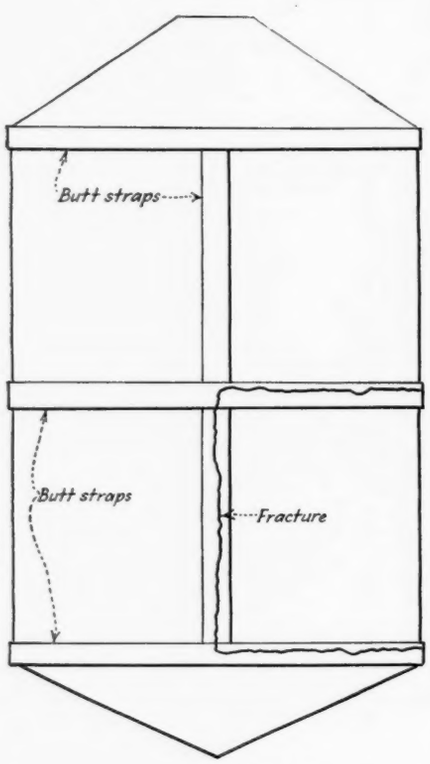
Plattsburg, N. Y.

Investigation Reveals Cause of Digester Explosion

ON THE afternoon of Tuesday, Aug. 12, 1930, digester No. 16 at the Burgess Sulphite Mill, Berlin, N. H., owned by the Brown Company, exploded. Two men were killed and five were injured. One end of the digester house was demolished and the acid system was completely wrecked. There was no concussion; in fact, residents near by were unaware of the occurrence. Detailed information has lately become available.

The digester, erected in April, 1906, was composed of two cylindrical courses, 15 ft. in diameter and 10 ft. 3 in. in length. The ends of the digester were sharply tapered. The cylindrical portions were of 1-in. flange steel composed of three plates joined by triple-riveted single-strap butt joints. The cover plates were $1\frac{1}{8}$ in thick. The inside rivet heads were countersunk, while the outside ends were upset into pan heads. This construction gave a mathematical efficiency of 69.6 per cent. The girth seams were of butt double-riveted single-strap construction.

THE failure occurred in one of the longitudinal butt straps on the lower cylindrical course. This strap cracked through the center rows of rivets and throughout its entire length as shown in the photograph. The top girth seam failed by shearing six rivets and then tearing the girth seam butt strap for approximately one-half the circumference of the vessel at the top center row of rivets. The bottom girth seam failed by shearing 39 rivets and then tearing the bottom girth seam butt strap at the top center row of rivets. The section of the bottom cylindrical course was distorted in such a manner as to indicate that the failure of the center girth seam preceded the failure of the bottom girth seam, and, as the failure proceeded, the bottom edge of the plate was held by the overlap of the bottom butt strap until the pressure exerted on the plate caused it to distort enough to pull from under the butt strap. When this occurred the failure of the bottom girth seam continued by tearing at the top center row of rivets rather than by shearing the rivets.



Diagrammatical layout of the digester and the path of the rupture

The reaction set up by the escaping contents of the digester threw it through the building wall, while the discharged contents blew out the opposite wall.

The digester was lined with two courses of brick, with a silicate backing against the plate. The brick lining had been replaced in July, 1929, but the original silicate backing had never been removed from the shell. Acid had not penetrated the lining sufficiently to cause any deterioration of the shell, for there was no evidence of acid-cutting or corrosion of any kind on any portion of the shell.

Steam used in the digester was obtained from two extraction turbines, as well as from a battery of high-pressure boilers through a reducing valve. At the time of the accident the extraction turbines were in service and the reducing valve was not in use. An examination of the recording charts shows that the pressures were 112 lb. gage in the line and 70 lb. at the digester. The recording thermometer shows a temperature of approximately 284 deg. F.

The steam piping system was arranged to eliminate the possibility of high-pressure steam's entering the digester line unless the reducing valve failed. As a means of protection against this possibility the low-pressure steam line in the digester house was fitted with six 4-in. safety valves, set to operate at a pressure of 125 lb. These safety valves had been replaced about three months previous to the accident and were in excellent condition. The reducing valve was discovered to be leaking slightly, but this leak does not appear to have had any effect on the steam pressure in the low-pressure line, since the pressure chart showed a pressure of only 110 lb. per square inch.

The digester was blown at 3:10 on Sunday morning, Aug. 10. It was not put into operation for $54\frac{1}{2}$ hr., during which time, however, it was heated with live steam to prevent its cooling. At 9:45 a.m. on Aug. 12 it was again steamed up and brought to its normal cooking pressure of 70 lb. in 1 hr. and 50 min. The pressure was held at 70 lb. as the cook progressed, while the temperature rose normally to 284 deg., at which point it remained for approximately $2\frac{1}{2}$ hr. before the failure occurred.

The vertical butt strap that failed

IMMEDIATELY after the explosion the Brown Company and the boiler insurance company started an investigation into the causes of the failure and the safety of the remaining digesters in the plant. Samples of the steel were removed from all of the longitudinal straps and from several of the shell plates, and preliminary tests for ductility were made in the plant. The samples were also submitted to metallurgical experts for careful study. While these tests are not yet completed, even the preliminary work disclosed that some of the metal was unsatisfactory. Furthermore, it was concluded that the single butt-strap type of riveted construction is poor practice in vessels which must withstand repeated cycles of varying internal pressure. In view of these facts, the Brown Company is removing all of the single-strap digesters from its plants.

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ACCORDING TO REPORTS received by the Bureau of Mines, Department of Commerce, the production of crude petroleum in the United States during October amounted to 72,696,000 bbl., a daily average of 2,345,000 bbl. This represents a decline in daily average from the previous month of 21,000 bbl. and marks the fifth successive month in which production has shown a decrease.

NEWS of the FIELD

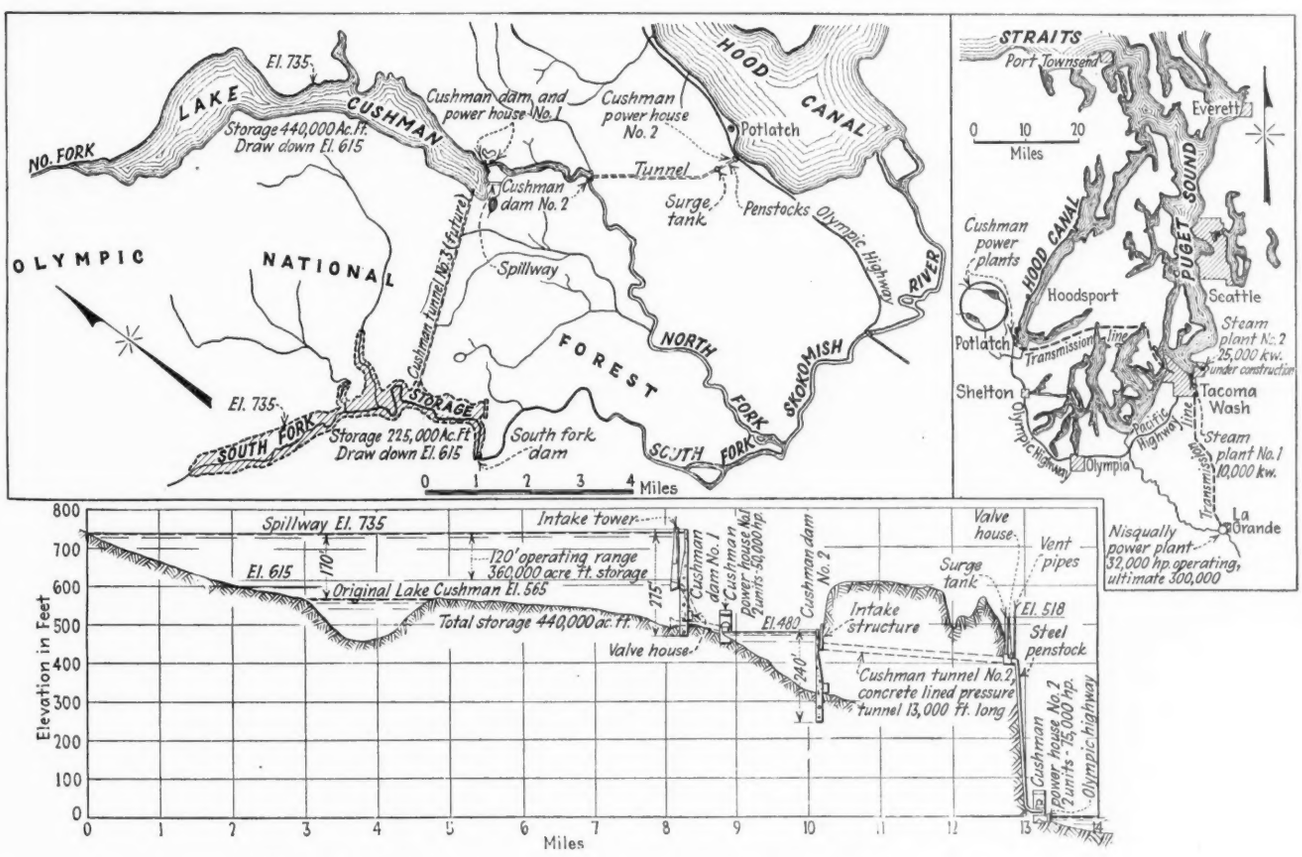
Lake Cushman Hydro Plant Nears Completion; Will Add 75,000 Hp. to Tacoma's Supply

CUSHMAN hydro-electric plant No. 2 of the city of Tacoma, Wash., is now practically completed. This plant will add 75,000 hp. to the city's system and will use the water discharged from plant No. 1 under a 480-ft. head, dropping to sea level on Hood Canal, as indicated in the figure. It will develop with the amount of water available 219,000,000 kw.-hr. per year. The first plant went into operation March, 1926, having a capacity of 50,000 hp. Construction of plant No. 2 began in the spring of 1929 and the plant is scheduled to go into operation this month.

An arch dam 240 ft. high is constructed in the river canyon two miles downstream from the first development. The dam creates an artificial lake having the same level as the water discharged from plant No. 1. A reinforced concrete-lined tunnel, 13,000 ft. long, of circular section 17 ft. in diameter, will carry the water from the lake created by the dam to a point 400 ft. above sea level on the hillside above the Hood Canal near Potlatch. This tunnel has a capacity of 2,900 cu.ft. per second and is constructed to handle the flow of the South Fork and North Fork of the Skokomish River. The development of the South Fork is contemplated at some future date, at which time the waters of that river will be diverted into the present basin on the North Fork at a point above the dam for No. 1 plant. This development will bring the capacity of the Cushman plants to 162,500 hp. and the annual energy output to 540,000,000 kw.-hr.

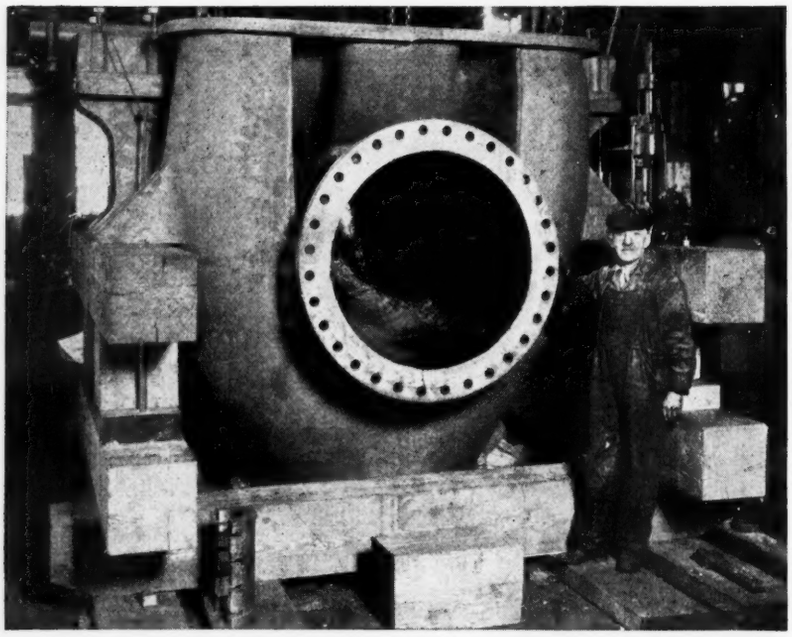
Spanning a narrow rock gorge the dam for plant No. 1 is 275 ft. high and 52 ft. thick at the bottom, tapering to 8 ft. at the top. The tunnels are of circular section, the power tunnel being 17 ft. in diamteer and the diversion tunnel 10 ft. Water is delivered from the power tunnel through two 12-ft. concrete penstock tunnels into two riveted-steel penstocks each with a diameter of 10 ft. After passing through the wheels, the water discharges into the old river bed in front of the power house.

No. 2 power house is on the Olympic Highway one-half mile south of Potlatch and is constructed to house three 37,500-hp. units, two of which are installed. A third machine will be part of the development of the South Fork of the Skokomish River. Energy from this plant will be delivered to the existing transmission lines, connecting Cushman plant No. 1 to the city of Tacoma. Power is generated at 13,200



Plan and elevation of Lake Cushman hydro-electric project of the City of Tacoma

A PACIFIC COAST GIANT



Half of a pump, which is said to be the largest ever made on the Pacific Coast, to be installed at Station "A," the Pacific Gas & Electric Company's steam plant at San Francisco. The pump will circulate salt water through the cooling system of two steam turbines. Cast in semi-steel, it is almost 9 ft. square, more than 7 ft. high and weighs 20 tons. Its double suction inlets are 3 ft. in diameter and its capacity is 40,000 gal. a minute. It was constructed by the United Iron Works of Oakland, Calif.

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volts, and stepped up through transformers to 115,000 volts for transmission to Tacoma.

The transmission line, consisting of two duplicate circuits, capable of carrying the full plant capacity in an emergency, is 44 miles long. This line crosses a 6,244.5-ft. gap over Puget Sound and is the longest electrical span in the world. Any other route or crossing would have greatly increased its length. The narrows, bounded by steep bluffs, is subject to swift treacherous currents that made impractical the use of submarine cables. Supporting towers for the span are 315 ft. high and weigh 150 tons each. At their base the legs stand on the corners of a 54-ft. square.

A new 25,000-kw. steam-electric generating plant is being built. This plant is to be used as a stand-by during periods of low water and is expected to be ready for operation about the same time as No. 2 Cushman plant. It provides for an initial installation of one 25,000-kw. steam-turbine generator and two boilers. Ultimately, there will be four such units, to be built as required. The boilers of the first unit will operate at 400 lb. pressure and will be fired with pulverized coal. Contract has been let for this fuel, which will be mined in Washington some 30 miles from Tacoma.

The information in this story was supplied by Llewellyn Evans, superintendent of lighting, Department of Public Utilities, Tacoma.

Open Memorial Exhibit to Elmer A. Sperry

A special exhibit memorializing the life and scientific achievements of Elmer A. Sperry, inventor of the gyrocompass and more than 350 other significant inventions in virtually every major field of science and industry, opened on Dec. 1 for one month's showing at the Museums of the Peaceful Arts in New York City.

Mr. Sperry's death on June 16 was universally described as marking the passing of one of the outstanding figures in the province of American invention. Mr. Sperry was past president of the American Society of Mechanical Engineers and a trustee of the Museums of the Peaceful Arts.

The special exhibit, held in conjunction with the fifty-first annual meeting of the A.S.M.E., which began Monday and continued through Friday, will be one of the first attempts ever made to portray in a single exhibit the services and achievements of a distinguished American inventor. The exhibit will include complete operating gyro-pilot equipment—the "Metal Mike" of the seas that unfalteringly keeps a vessel to its true course, one of Mr. Sperry's later and most dramatic inventions. An operating model of the ship stabilizer, which overcomes rolling and pitching, will also be on display.

At the entrance to the exhibit there will be a 60-in. aircraft searchlight, one of Mr. Sperry's inventions that ranks him with Sir Humphrey Davy in his discovery of the electric arc. Other photographs, models and actual apparatus will portray Sperry's early experiments with water wheels, hydraulic turbines, the dynamo, the electric arc, and on through the period of his invention of storage batteries, electric locomotives, electric automobiles, electric trolleys, Diesel engines, "rail-detector," various mining mechanisms and metallurgical devices, submarine alarm, gunfire control devices and others of the outstanding Sperry inventions.

A section of the exhibit will be devoted to the presentation of the various honors which Mr. Sperry received during his 48 active years as an inventor, consisting of diplomas, medals and other honors awarded to him by his own and foreign countries as well as by various engineering and scientific societies.

The exhibit is open to the public without charge daily, except Sundays and holidays, from 10 a.m. to 5 p.m. In addition to the Sperry memorial exhibit, the major part of the "Men and Machines" exhibit, epitomizing the rise of the Machine Age, will be kept open for another month.

Ohio Commission Rules on Natural Gas Rates

The Ohio Public Utilities Commission, in an order issued recently, held that when a natural gas distributing company seeks an increase in rates for gas received from a transporting company of which the distributor is a subsidiary, the burden is on the distributing utility to show that the contract price is just and reasonable to the company and to the consumer.

"Where a public utility distributing natural gas," the syllabus to the Commission's order said, "applies for an increase in rates and it appears that such utility has entered into a contract to pay a transportation company a gateway price of 45 cents per 1,000 cu.ft., and it further appears that said contract was made under the supervision of a managing company and that all the common stock of the distributing company, the transportation company and the managing company is owned or controlled by the same holding company, the burden is upon the company asking for an increase in rates to show that the gateway price is just and reasonable to the distributing company and to the consumer."

The order was issued in connection with an application for an increase of rates by the Dayton Power & Light Company for natural gas furnished in eight towns in the vicinity of Dayton. The company, according to the order, owns the gas distribution systems in the towns and supplies natural gas only. It does not own any transmission pipe lines, but buys gas at 45 cents per 1,000 cu.ft. at the several city gates from the Ohio Fuel Gas Company.

Unemployment Conference Called for Dec. 29-31

A national conference to consider permanent methods for combating unemployment through governmental and private agencies has been called by the American Association for Labor Legislation to meet at Cleveland, Ohio, Dec. 29 to 31. Announced as the Third National Conference on Unemployment, this meeting will bring together the leading authorities on unemployment problems, including representatives from the official state and city unemployment committees. It will meet in conjunction with the twenty-fourth annual meeting of the association, which held similar unemployment conferences in 1914 and 1921. Related organizations, including the American Economic Association, will participate in joint sessions.

Many prominent experts on unemployment problems have already indicated that they will attend the conference. Among those who will speak are Senator Robert F. Wagner of New York, on "Unemployment—A National Issue"; Bryce M. Stewart of the President's Emergency Committee, "What We Knew About Unemployment in 1930"; Whiting Williams, "What's on the Workless Worker's Mind"; Leo Wolman, "An American Plan for Unemployment Insurance"; Florence Thorne of the American Federation of Labor, "Technological Unemployment"; B. C. Seiple of the Cleveland City-State Employment Service, "Public Vs. Private Employment Offices."

To Add 100,000-Kw. Unit to Long Beach Station

Announcement has just been made by the Southern California Edison Company that it will expend $8,620,000 during 1931 for the installation of a 100,000-kw. turbine-generator and fuel-supply equipment in its steam-electric generating station at Long Beach. This expenditure will be one of the largest items in the 1931 construction budget of the company. Addition of the new unit will raise the generating capacity of the Long Beach plants to approximately 400,000 kilowatts.

Light Metals Group Formed by A.S.A.

Formation of a light metals group, with the Aluminum Company of America as the first member of the group, is announced by the American Standards Association. This group becomes the 45th member-body of the association with representation on the A.S.A. Standards Council.

The council now includes organizations of national scope representing a large proportion of the major branches of the manufacturing, mining, and public utility industries, national engineering societies, safety and insurance groups and several departments of the federal government. Other industrial groups represented on the council in addition to individual national trade and technical organizations are the electric light and power group, the fire protection group, the small tools group, and the telephone group, each consisting of a number of trade associations, or industrial units of comparable scope and magnitude, and allied interests.

It is expected that the creation of the light metals group will greatly stimulate the establishment of national standards and specifications covering the processes and products of the light metals industry, which include aluminum and magnesium, their alloys, and alloys of these metals with other metals.

Commission Issues Licenses for Alaska Projects

Licenses under the water power act covering important projects in Alaska where large-scale manufacture of newsprint paper is to be undertaken have been approved by the Federal Power Commission for George T. Cameron, of San Francisco, and for I. & J. D. Zellerbach, also of San Francisco.

The Cameron application is persuant to preliminary permits issued June 16, 1927 and June 5, 1930. It is proposed to develop 80,500 hp. on Long, Crater and Dorothy Lakes near Juneau. The license is to be subject to certain conditions which will be made by the Forest Service and with certain reservations as to items of prelicense costs.

The Zellerbach license is pursuant to a preliminary permit issued June 16, 1927. It covers a 65,500 hp. installation on Mirror Lake and Fish Creek and on Ella, Manzanita, Grace, Swan and Orchard Lakes near Ketchikam on Revillagigedo Island. Similar reservations were made in this case also.

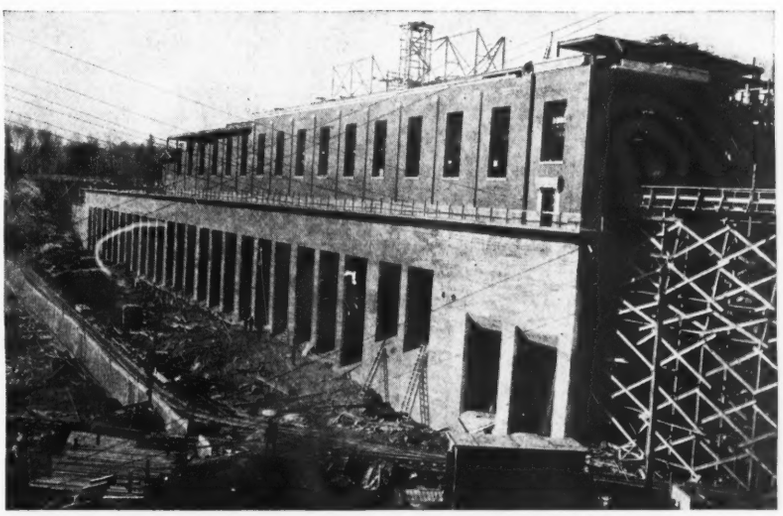
News of Canada

Seventh 34,000-hp. unit to be installed at Paugan — Vancouver may have natural gas —Progress on Abitibi Canyon project

INSTALLATION of another 34,000-hp. generator in the Paugan, Quebec, hydro-electric plant of its Gatineau Power Company, will be started soon by the International Paper & Power Company. Already one of the greatest hydro-electric stations in North America, Paugan will have an installed capacity of 238,000 hp. upon the completion of the new unit, and will then be the largest hydro-electric development of the company. When the new Paugan unit is in operation, the company will have installed and in operation in a 26-mile stretch of the Gatineau River, an aggregate of 470,000 horsepower.

As the new generator is the seventh of eight units which can be housed by the Paugan power house, only the cost of the machinery will be involved in the installation. The space for the eighth unit at Paugan and for an additional generator in each of the other two large hydro-electric plants of the company on the Gatineau River will permit without power house expansion, the further installation of 92,000 hp. when required by the growing demand.

WELDING FIRMS depending upon gas supply will be interested to learn that there is now considerable likelihood of natural gas being available for this purpose in the City of Vancouver, B. C., as well as adjoining areas. The gas will be supplied from a huge acreage which is being developed, it is stated, near Steveston on Lulu Island, B. C. The development has been undertaken by International Pipe Lines Limited and if the plans of the company mature,



Recent construction view of Slave Falls project on the Winnipeg River in Manitoba, showing progress made on the power house and dam. This plant is designed for an ultimate installation of eight 12,000-hp. units, two of which are expected to be in operation by September, 1931

according to schedule, gas will be piped into Vancouver within a period of three months or less.

V. J. Freeman of Vancouver, vice-president and general manager of the firm, states that the company will make no effort to disturb existing distributing agencies, but will bring its gas into the city and sell it to the British Columbia Electric Railway Company's gas department. The International Pipe Lines' leases in Steveston cover 50,000 acres, according to Mr. Freeman, and he adds that a well there has already been developed, while another at Boundary Bay showed gas at three levels.

WORK on the 275,000-hp. hydro-electric development at Abitibi Canyon, the largest in northern Ontario, is going forward on time. Already contracts are being drawn for equipment and machinery to be installed next year. Thus far, all contracts have gone to Canadian firms. The contract for five 66,000-hp. water wheels for the new development has just been awarded to the Allis-Chalmers Company of Toronto. The Dominion Bridge Company of Montreal will make the five penstocks. Tenders are now being called for on five 55,000-kva. generators. The development at Abitibi Canyon is being done by the Ontario Power Corporation, a subsidiary of the Abitibi Power Company, under contract with the Ontario Government. Of the 275,000 hp. to be developed, 100,000 hp. will be sold to the Ontario Hydro-Electric Power Commission by the private company developing.

Navy Trying to Convert Gasoline Engines to Oil

Experiments of far-reaching importance are now being conducted by the navy in an effort to ascertain the feasibility of converting gasoline-burning engines into oil-consuming engines. The government-constructed B A engine appears to be the best adapted to such a conversion, and is the one on which the tests are now being made. If the switch from the gasoline engine to the oil-burning motor proves practical and inexpensive the power plants of the navy's motor launches will be converted. The change would not be wholesale but would be effected at the time the individual launches required overhauling.

The fire hazard is especially prominent in motor launches, and the navy is particularly desirous of developing any mechanical means which will lessen it, officials declare. Gas engines employed by the navy in such craft have set a high record for reliability, which must be equalled by the oil-burning engine before any conversion of the gas engines into oil-burning engines can be approved, even though such conversion may be practical and inexpensive. There are some thousand motor launches and small boats which would be affected by such a change.

COMING CONVENTIONS

American Society of Mechanical Engineers. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Annual meeting at the Mayflower Hotel, Washington, D. C., Jan. 15-17, 1931. Secretary, L. W. Wallace, 26 Jackson Pl., N.W., Washington, D. C.

American Institute of Electrical Engineers. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29, 1931. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

Engineering Institute of Canada. Annual meeting at the Windsor Hotel, Montreal, Que., Feb. 4-6, 1931. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

Fourth Liquefied Gas Plant Completed Within Month

Thanksgiving week marked the completion by the Natural Gas Corporation of California of the fourth California plant during the past month, with the turning on of gas at Suisun-Fairfield. Other plants recently completed by this organization include one at Vacaville, a second at Brawley and a third at Calexico, while several additional plants will be completed and put into operation within the next few weeks.

The service of gas to these communities has been made possible through the development of Butane Gas by the Natural Gas Corporation of California. This new fuel is shipped in liquid form in tank cars from the oil fields to an especially constructed plant in each community where it is vaporized and distributed through the usual system of pipes. This has made gas service possible in communities where it has heretofore been felt impractical to construct manufactured gas plants, and will be of material advantage in the development of these various territories.

Natural Gas Corporation of California is making rapid progress in the huge development program outlined earlier in the year for the bringing of gas to numerous communities throughout the state, according to R. E. Aitcheson, executive vice-president.

At this same time, he reported rapid progress also being made by the Natural Gas Corporation of Oregon and Natural Gas Corporation of Washington, with service to be commenced very shortly in these two states.

Personals

LEONID K. RAMSIN, professor at the State Thermo-Technical Institute in Moscow, Russia, whose original research on combustion, fuels and furnaces furnished the basis for three of the most brilliant and interesting papers contributed to the World Power Conference held in Berlin last June, is now on trial in Moscow together with seven other prominent engineers on charges of conspiring to overthrow the Soviet Union. If convicted, Professor Ramsin is liable to receive the death penalty.

J. M. BARRY, vice-president in charge of operations of the Alabama Power Company, was elected a director of the company at a recent meeting of its board of directors. Mr. Barry, who supervised the construction of the company's Mitchell Dam project, has had a wide experience in public utility power station engineering.

J. E. HART, formerly general superintendent of the Boston Works of the Walworth Company, has been made works manager. Other recent changes in the Boston Works' organization include the appointment of J. FRANK DORNEY as assistant works manager and the appointment of CHESTER L. ERICKSON as superintendent of production.

H. A. VAN NORMAN, chief engineer and general manager of the Los Angeles Bureau of Water Works and Supply, has been placed in charge of the joint divisions of the city's Department of Water and Power, as the first step in the reorganization of the department. Two new positions of electrical engineer and assistant electrical engineer have been created in the department and CARL HEINZE and CARL CHAPIN, respectively, have been appointed to fill them.

T. V. MCCARTHY is now with the Dominion Construction Company at Abitibi Canyon, Ont. Mr. McCarthy, who was formerly with H. G. Acres & Company, Ltd., was at one time assistant laboratory engineer with the Hydro-Electric Power Commission of Ontario.

J. B. BARNUM has joined the staff of the Beauharnois Power Corporation, Beauharnois, Que., as field engineer. Mr. Barnum was formerly with the Gatineau Power Company, Ottawa. He has at various times been connected with the Foundation Company of Canada and the Riordon Pulp Corporation.

GORDON MITCHELL, formerly superintendent of construction with the Hydro-Electric Power Commission of Ontario, at Nipigon, Ont., is at present with the Dominion Construction Company at Fraserdale, Ont. Mr. Mitchell was at one time resident engineer for the Spruce Falls Power & Paper Company at Smokey Falls, Ont.

Business Notes

WICKES BOILER COMPANY, Saginaw, Mich., announces the appointment of H. E. Jacobsen, Room 200, Engineering Building, 205 West Wacker Drive, Chicago, Ill., as its district representative for heating boilers.

CENTRIFIX CORPORATION, Cleveland, Ohio, announces the appointment of John F. Nulty as Eastern railway sales representative, with headquarters in Philadelphia, Pa. Prior to coming with Centrifix, Mr. Nulty was associated with the Baldwin Locomotive Works.

HENRY VALVE COMPANY, Chicago, Ill., announces the appointment of the A. P. Miller Supply Company, 332 West 21st St., New York City, as its Eastern distributor for refrigeration valves and fittings.

DAMPNEY COMPANY OF AMERICA, Hyde Park, Mass., announces the opening of a direct company branch office at 53 West Jackson Blvd., Chicago, Ill., to serve the Middle West territory. R. G. Ingram, J. D. Bird and C. M. Boling will have their headquarters in Chicago.

READING IRON COMPANY, Reading, Pa., announces the resignation of A. M. Cullum as "oil-country" sales manager with headquarters in Tulsa, Okla. Mr. Cullum has been associated with the company for the past ten years, starting as a clerk in the Roe puddling plant. He will take a position with the Harbison-Walker Refractories Company of Pittsburgh. The Reading company also announces the appointment of R. W. Thompson, advertising manager, as director of public relations, and the appointment of Harold S. Bard as district sales representative with offices at 1714 Engineering Building, Chicago, Ill. Mr. Bard, who has been associated with the company for the past seven years as salesman in the New York district, succeeds R. A. Griffin, who has resigned.

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Trade Catalogs

PUMPS—Bulletin No. 1647 illustrating and describing Type SSU centrifugal pumping units has just been issued by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Head capacity tables and charts of output are included in the bulletin.

SPEED REDUCERS—Foote Bros. Gear & Machine Company, 111 North Canal St., Chicago, Ill., has recently issued a new catalog, No. 102, on helical and herringbone gears. This catalog covers complete information on the company's new IXL Titan helical-gear speed reducers, having heat-treated and hardened gears, and on IXL Titan herringbone speed reducers of entirely new design. Data is also included on a new method of rating used to show horsepowers, inch-pounds torque, slow- and high-speed revolutions per minute.

NICKEL ALLOY STEELS—A tabulation of sources of supply for the more commonly used forged, rolled, cast and drawn products made from nickel steels and alloys is given in "The Buyers' Guide to Nickel Alloy Steel Products," just published by the International Nickel Company, 67 Wall St., New York City. Materials listed in this Fall, 1930, issue of the guide are the standard nickel steel alloys, the nickel-chromium corrosion- and heat-resistant steels and special ferro-nickel alloys.

PUMPS—A new 104-page book of particular interest to those responsible for the installation, care and maintenance of pumps has just been published by the Geo. D. Roper Corporation of Rockford, Ill. Rotary pumps for hydraulic service, transfer of power and circulation of coolants are fully illustrated and described. Besides, the book contains engineering tables and data and much valuable information on installing pumps, determining the power required for pumping, formulas for finding the size and speed of pulleys and gears, definitions of terms used in referring to pumps, and the pump construction necessary for different types of liquids.

WELDING—The Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill., has just published a catalog of electric arc welding accessories and supplies. A complete line of these items is illustrated and described with net prices included.

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WITH THE SOCIETY SECTIONS

A.S.M.E., Baltimore Section. Joint meeting with the A.I.E.E. and A.S.C.E. at the Engineers Club on Dec. 11. Subjects: "Baltimore Sewerage System," by C. F. Keefer, city engineer; "Improvements to the Water Supply System With Reference to the New Vernon Pumping Station," by Leon Small, mechanical engineer; "The Electrical Activities of the City of Baltimore," by Warren Viessman, head of the Bureau of Electrical-Mechanical Services.

A.S.M.E., Bridgeport Section. Meeting in the auditorium of the General Electric Company's plant on Dec. 9 at 8 p.m. Subjects: "Atomic-Hydrogen Welding Process" and "X-Ray Examination of Metallurgical Structures," by Colonel Dickson of the Watertown, Mass., arsenal; also, "X-Ray vs. Metallurgical Development in Conjunction With the General Electric Company at Schenectady and Watertown Arsenal."

A.S.M.E., Detroit Section. Meeting in the Detroit Engineering Society Building on Dec. 15. Subject: "Steam Turbines for High-Pressure Power Stations," by G. B. Warren, General Electric Company.

A.S.M.E., San Francisco Section. Meeting at the Engineers Club on Dec. 18 at 7:30 p.m. Subject: "The Effect of Turbulence in Centrifugal Pumps," by J. W. Macmeeken, Byron Jackson Company.

A.I. & S.E.E., Philadelphia Section. Meeting at the Engineers Club on Jan. 3 at 7 p.m. Subject: "Automatic Lubrication in Steel Mills," by Horace B. Cleveland, Bethlehem Steel Company.

Providence Engineering Society. Power section meeting in the society rooms on Dec. 12 at 8 p.m. Subject: "Modern Water-Cooled Furnace Design as Applied to Boiler Furnaces," by H. K. Dean, Fuller Lehigh Company. Meeting on Dec. 16 at 8 p.m.; subject: "Vibration," by J. Ormondroyd, Westinghouse Electric & Manufacturing Company.

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Fuel Prices

FUEL OIL

New York—Dec. 3, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 29, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.47 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.651c.@4.776c. per gal.

Pittsburgh—Nov. 26, f.o.b. local refinery, 34@36 deg., fuel oil, 3.37½c.@3.75c. per gol.; 36@40 deg., 3.5c.@3.75c.

Philadelphia—Nov. 25, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati—Nov. 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 25, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 80c.@90c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—Nov. 24, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

Dallas—Nov. 29, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, hr.gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.75 @ 2.25
Smokeless, slack	Chicago	50 @ 1.35
Harlan, Ky., slack	Chicago	.50 @ .90
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.10 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.50 @ 1.85
Standard Ill., mine-run	St. Louis	1.70
W. Ky., mine-run	Louisville	1.00 @ 1.35
W. Ky., slack	Louisville	.15 @ .30
Pittsburgh, mine-run	Pittsburgh	1.30 @ 1.60
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	.75 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.35 @ .50

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15 @ 1.50

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Florence—Randolph Irrigation District, plans the construction of thirty-four complete pumping plants and wells, in connection with waterworks system. Estimated cost $624,000. Scott Engineering Co., Ellis Bldg., Phoenix, are engineers.

Ariz., Tucson—Tucson Gas, Electric Light & Power Co., A. M. Pooler, Gen. Mgr., will receive bids about Jan. 1, for extensions and improvements including 4,000 hp. Diesel engine power plant, extension to power house, cooling tower, etc. Estimated cost $500,000.

Calif., Millbrae — Millbrae Utility District, plans an election soon to vote $15,000 bonds for waterworks including pipe distribution system, storage tank, pumps, etc. G. A. Kneese, Court House, Redwood City, is engineer.

Calif., Oakland—East Bay Municipal Utilities Dist., has made application to Federal Power Commission for preliminary permit to construct a hydro-electric project, 4,100 hp. capacity, on the Mokelumne River. Plans include a dam, reservoir and power plant at Middle Bar site, just upstream from Sancha Plana plant.

Calif., Pasadena—City, B. Chamberlain, Clk., received lowest bid for steam generating equipment including two 15,000 sq.ft. boilers, two sets of tubes, headers, connections, recirculators, etc., for municipal light plant from C. C. Moore Co., Sheldon Bldg., San Francisco. $141,140.

Colorado — Public Service Co. of Colorado, C. N. Stannard, V. Pres. and Gen. Mgr., 15th and Champa St., Denver, plans to expend $3,300,000 in 1931 for improvements and rehabilitation to include construction of transmission and distribution lines and purchase of metering equipment and transformers; improvements and additions to steam and hydro-electric plants at Sterling, Grand Junction, Alamosa, Boulder Canyon and Shoshone; central steam heating system, now operated from West station, will be tied in with Lacombe station, Denver which is to be relieved of much electrical load by Valmont's (near Boulder) new boiler installation.

La., Westwego—Louisiana Ice & Coal Co., C. H. Free, Mgr., 1121 Julia St., New Orleans, will soon award contract for a 35 x 56 ft. addition to cold storage plant, here.

Md., Baltimore—Bd. of Awards, City Hall, will receive bids until Dec. 17, for the construction of a 7 story library including vacuum heating system, elevators, etc. at Cathedral, Mulberry and Franklin Sts. Estimated cost $2,000,000. C. N. and N. Friz, Lexington Bldg., are architects. H. Massart, 328 North Charles St., is engineer.

Mass., Everett (Boston P. O.)—Edison Electric Illuminating Co., 39 Boylston St., Boston, is having plans prepared for the construction of a power plant and switching house extension at Mystic Station, Alford and Dexter Sts., here. Estimated cost $3,000,000. Stone & Webster, 49 Federal St., Boston, are engineers.

Mo., Sikeston—City awarded general contract for the construction of a 40 x 80 ft. municipal light and power plant including oil storage reservoir, 200 g.p.m. cooling tower complete, two 600 hp. Diesel engine generator units, two separately driven exciters and auxiliaries to Fairbanks-Morse Co., 217 South 8th St., St. Louis. $123,600. Power plant building sub-let to Sutterfield & Weltcke, Sikeston, $15,355, and installation of electric distribution system, switchboard and station wiring, to R. H. Bouligny Co., Inc., Charlotte, N. C. Estimated total cost $150,000.

N. H., Exeter—Phillips Exeter Academy, L. Perry, is having preliminary plans prepared for additions to main building including central heating plant at Academy grounds. Estimated cost to exceed $40,000. Cram & Ferguson, 248 Boylston St., Boston, Mass., Archts.

N. J., Montclair — Rudgers Builders Supply Co., 101 Greenwood Ave., will build a 1 and 2 story, 102 x 352 ft. boiler house, shop, garage, etc. Estimated cost $150,000. Private plans. Work will be done by separate contracts. Public Service Production Co., 80 Park Pl., Newark, is lessee.

N. J., Preakness—Bd. of Chosen Freeholders, Court House, Paterson, is having revised plans prepared for a 3 story welfare house and detention home including steam heating system, etc. on Oldham Rd. Estimated cost $600,000. F. W. Wentworth, 140 Market St., Paterson, is architect.

N. Y., Auburn — Dept. of Correction, State Capitol, Albany, received lowest bid for the construction of a new power plant, foundry shop, etc. at Auburn Prison here, from Wark Co., 120 Broadway, New York.

O., Cleveland—City, D. S. Blossom, Dir. of Public Welfare, is having plans prepared for a 4 story tuberculosis sanitorium including steam heating system, etc. on Scranton Rd., also a 5 story addition at Warrensville Farm. Estimated cost $1,000,000 and $250,000 respectively. H. Kregelius, 504 City Hall, is architect.

Okla., Hominy—City plans an election Dec. 16 to vote $150,000 bonds for the construction of a municipal electric light plant. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pennsylvania—Western Ice & Utilities Co., J. M. Whitsett, Gen. Mgr., Donora, plans the construction of an ice plant at Monessen, also plant at Charleroi. Latter will be built by day labor.

Tex., Brownsville—Cameron, Willacy, Hidalgo and Cameron Counties or U. S. and Mexican Governments, plan the construction of a master irrigation district for system of dams, probably four dams for storage water for irrigation and power purposes. Estimated cost $10,000,000.

Tex., Lubbock — West Texas Technical College, had plans prepared for the construction of a 1 story power plant. Estimated cost $20,000. W. C. Hedrick, 1005 First National Bank Bldg., Fort Worth, is engineer.

Tex., Tenaha—City plans an election Dec. 5, to vote $35,000 bonds for the construction of a waterworks and distribution system including pumping equipment, etc. J. H. Womack, City Mgr.

Wash., Seattle — Bd. of Public Works, received lowest bid for furnishing excitation and regulation equipment for Lake Union steam auxiliary plant of city light department from Elliott Co., $19,000.

Wash., Seattle — Bd. of Public Works, received lowest bid for furnishing materials and constructing foundations for power house in connection with Diablo hydro-electric development on the Skagit River, from Ward Construction Co., Tacoma. $279,847.

Wis., Milwaukee—Terminal Warehouse Co., 106 West Seeboth St., awarded contract for concrete work for a 5 story, 62 x 120 ft. addition for cold storage warehouse to Selzer-Ornst Co., 444 State St., Wauwatosa.

Que., Mont Laurier — Town Council, plans to expend $260,000 for extensions and improvements to power plant including the installation of new turbines and generators. S. Quimet, 706 St. Gabriel St., Montreal, is engineer.

Alaska—G. T. Cameron, c/o San Francisco Chronicle, 5th and Mission Sts., San Francisco, Calif., has made application for permit to construct a hydro-electric plant and pulp and paper mill in vicinity of Juneau at Long, Crater and Dorothy Lakes. Estimated cost approximately $15,000,000. Maturity indefinite.

Alaska—H. Chandler, c/o Los Angeles Times, 100 North Broadway, Los Angeles, Calif., has made application to Federal Power Commission for permit to construct a hydro-electric project and pulp and paper mills in vicinity of Juneau. Estimated cost approximately $15,000,000. Maturity indefinite.

Alaska—I. and J. D. Zellerbach, c/o Zellerbach Paper Co., 534 Battery St., San Francisco, Calif., has made application to Federal Power Commission for permit to construct a hydro-electric power plant and pulp and paper mill in vicinity of Kolchikan. Estimated cost approximately $15,000,000.

Alaska, Kelchikan—Citizens Light, Power & Gas Co. has made application for preliminary permit to construct a dam on Lake Perseverance, also tunnel extension to lower Kelchikan Lake, a distance of 6,000 ft.

Equipment Wanted

Conveyor System—Milwaukee, Wis.—Sewerage Commission, will receive bids until Dec. 19, for furnishing, fabricating, delivering and erecting a conveyor system in extension to dryer house.

Pump—Monrovia, Calif.—City, E. A. Dupar, Clk., will receive bids until Dec. 15, for a booster pump for Ivy Ave. pumping plant.

Pump—Garfield Heights (br. Cleveland), O.—City plans to purchase a centrifugal pump, etc. for proposed waterworks improvements. Estimated cost $60,000.

Pump—Hollis, Okla.—City plans to purchase a 200 g.p.m. centrifugal pump against 140 ft. head.

Pump and Motor—Clarkton, Mo.—City will receive bids until Dec. 16, for a vertical pump and motor, etc. for proposed waterworks system. Estimated cost $20,000.

Pumping Units—Boulder City, Nev.—U. S. Bureau of Reclamation, will soon receive bids for three pumping units in three stages, first unit to pump river to settling basin, second unit settling basin to filler beds and third unit filler beds to tank in connection with waterworks.

Pumps—Chelan, Wash.—Howard Flat Irrigation District, C. R. Sargent, Secy., will receive bids until Dec. 19, for two 700 hp. centrifugal pumps, etc. for complete irrigation system.

Pumps and Motors—Phoenix, Ariz.—Camelback Water Conservation District, E. E. Young, Secy., plans to purchase 150 hp. deep well turbine pumps and motors, seven 10 to 200 hp. booster pumps, etc. for proposed waterworks system. Estimated cost $516,000.

Industrial Projects

Calif., Antelope—California Lime & Products Co., R. L. Hollingsworth, Gen. Mgr., is having plans prepared for the construction of a 200 ton per day lime plant and 50 ton dry ice plant. Estimated cost $500,000. Smith-Emery Co., 651 Howard St., San Francisco, are engineers.

Conn., East Hartford—The Texas Co., 31 St. James Ave., Boston, Mass., will receive bids until Dec. 12, for the construction of a terminal building including warehouse and boiler unit, 40 x 90 ft., garage, 42 x 80 ft. and two pump houses, each 15 x 16 ft., here. Estimated cost $50,000. Private plans.

La., New Orleans—Southern Pacific R.R., 65 Market St., San Francisco, Calif., plans the construction of a terminal warehouse including refrigeration plant here. Estimated cost $800,000. G. W. Boschke, San Francisco, is chief engineer.

Mo., Kansas City — Phillips Petroleum Co., Bartlesville, Okla., is having plans prepared for the construction of a 120 acre gasoline pipe line terminal station consisting of tanks and pumping stations near here. Estimated cost $400,000. A. H. Riney, Bartlesville, is engineer.

O., Lorain—National Stove Co., subsidiary of American Stove Co., plans the construction of an enameling plant and punch press plant. Estimated cost $500,000. Private plans. Machinery and equipment will be required.

Okla., Oklahoma City — Continental Oil Co., Ponca City, is having plans prepared for the construction of an oil booster pumping station, 12,000 bbl. daily capacity here, also 81 mi. of 8 in. oil pipe line from Oklahoma City to refinery at Ponca City. Estimated cost $25,000 and $500,000 respectively.

Okla., Oklahoma City — Reagan Brick Co., Hales Bldg., plans the construction of a brick and tile factory at 64th St. and Oklahoma Railway tracks. Estimated cost $250,000. Work will be done by day labor. Private plans.

Okla., Seminole — Empire Companies Inc., Bartlesville, is having plans prepared for the construction of a six unit casinghead gasoline plant between Seminole and Konawa, also near Pampa, Tex. Estimated cost $50,000 and $50,000 respectively. Private plans.

Tex., Houston—Lone Star Cement Co., 342 Madison Ave., New York, N. Y., plans addition to and expansion of cement plant here. Estimated cost $80,000. Maturity about Jan. 1. Machinery and equipment will be required (after Jan. 1).

Va., Richmond — Virginia Wood Preserving Corp., plans the construction of a plant near here. Estimated cost $300,000.

Wash., Seattle — A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt., will receive bids until Dec. 16, for the construction of a 1 and 2 story automobile assembly plant including oil house, separate power plant, etc. here for Ford Motor Co., 3674 Schaefer Rd., Dearborn, Mich. Estimated cost $500,000. Equipment, conveyors, etc., will be required.

Ont., Petrolea—Superior Sugars Ltd., F. J. Potter, Gen. Mgr., 4886 Maplewood Ave., Detroit, Mich., plans the construction of a sugar refinery including storage tank, crude oil burners, molasses storage tanks and complete equipment for machine and blacksmith shops, etc. here. Estimated cost $3,000,000.

Ont., Toronto—Canadian National Railways, New Union Station, plans the construction of a large warehouse for handling fruit shipments including cold storage facilities, etc. at Yonge St. and Esplanade Ave. Estimated cost $200,000. T. T. Irving, is chief engineer-Central Region.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES hold at November levels in practically all of the power-plant and electrical supplies listed in the accompanying tables. A slightly upward movement is indicated in prices of copper wire and BX cable, based on the recent advance in the asking price of copper metal at wholesale. The trend of buying in these materials has been downward since the autumn of 1929, with the exception of a slight spurt, which occurred at the outset of this year. Volume of orders is smaller now, perhaps, than in the corresponding period throughout the last six years.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft.		$0.65
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50–10%

Air—Best Grade, Net

¾-in., per ft.	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List

First grade.... 50% Second grade..... 50–5% Third grade.... 60–5%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade.....60% Second grade.....60-5%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—Cut lacing, best quality, 30-10%; 2nd quality, 50%. Lace leather sides, best, 12-17 sq.ft., 55c. per sq.ft.; 2nd, 48c., net. Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Asbestos for high-pressure steam, ½ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.10 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 400 to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	10.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.14½
New York (100 lb. bales)	.14
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.102	$0.107	$0.104

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.75

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	47.00
Commercial genuine, intermediate grade	34.00
Anti-friction metal, general service	30.00
No. 4 babbitt, f. o. b.	10.00

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3½ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$23.37	$38.24	$66.00	$86.75
No. 12 solid....	38.02	50.52	76.00	104.00
No. 10 solid....	52.10	66.22	95.00	124.00
No. 8 stranded..	85.34	105.22	133.00	185.00
No. 6 stranded..	123.58	148.81	180.00	253.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. 4 Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
⅜	$60.89	$8.31	$4.79	$55.67	$7.14	$4.36
½	77.61	10.94	6.85	70.53	9.41	6.24
1	111.26	16.35	8.94	100.80	14.07	8.14
1¼	150.53	22.47	12.59	136.38	19.71	11.54
1½	180.00	30.05	15.59	163.08	26.35	14.29
2	242.20	54.69	20.87	219.43	47.92	19.15
2½	382.95	90.49	29.81	346.95	79.41	27.34
3	500.80	233.74	44.70	453.72	204.21	41.01
3½	630.74	511.83	59.92	574.14	446.60	55.00
4	769.61	591.84	74.69	702.53	516.46	68.53
4½	896.51	892.12	111.40	818.37	777.99	102.16
5	1045.06	1240.73	122.91	953.99	1082.29	112.75
6	1355.64	1547.71	177.72	1237.49	1350.80	162.95

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package.....	15%	20%	28%
Less than standard package.....	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.....	$0.12	D. P. D. B.....	$0.31
D. P. M. L.....	.16	T. P. S. B.....	.35
T. P. M. L.....	.27	T. P. D. B.....	.47
D. P. S. B.....	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.....	$0.27	$0.70	$1.75
T. P. M. L.....	.40	1.00	2.30
D. P. S. B.....	.35	.87	.....
T. P. S. B.....	.67	1.50	.....
D. P. D. B.....	.65	1.75	.....
T. P. D. B.....	1.12	3.00	.....
T. P. to D. P. D. B.....	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy.....		$15.00
No. 16 cotton reinforced heavy.....		19.00
No. 18 cotton reinforced light.....		12.00
No. 16 cotton reinforced light.....		14.00
No. 18 cotton Canvasite cord.....		13.00
No. 16 cotton Canvasite cord.....		15.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.....	$64.00	*71.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.....	92.00	*101.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons.....	Net list
Unbroken cartons.....	17%
Ten unbroken cartons.....	34%
Discount Without Contract—Renewals:	
Broken cartons.....	Net list
Unbroken cartons.....	17%
Ten unbroken cartons.....	34%
Discount With Contract—Fuses:	
Broken cartons.....	5%
Unbroken cartons.....	20%
Ten unbroken cartons.....	36%
Discount With Contract—Renewals:	
Broken cartons.....	Net list
Ten unbroken cartons.....	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100.....	$2.50
0–30 ampere, less than standard package, per 100.....	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	...	.....
60	A 21	.20	...	...	.....
100	A 23	.35	...	...	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug.....	$0.18
Composition, 2-piece, attachment plug.....	.27
Swivel attachment plug.....	.12
Small size, 2-piece plug, composition.....	.06

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14.....	$4.75	$6.50	$7.10	$13.20
12.....	6.90	8.00	9.40	17.00
10.....	8.45	10.40	11.80	22.50
8.....	13.00	15.00	17.15	32.00
6.....	.....	.....	23.00	.....
4.....	.....	.....	34.00	.....
2.....	.....	.....	47.00	.....
1.....	.....	.....	70.00	.....
0.....	.....	.....	83.00	.....
00.....	.....	.....	95.00	.....
000.....	.....	.....	117.00	.....
0000.....	.....	.....	142.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	Keyless	Pull	¾ In. Cap Key	Keyless	Pull
Standard package.....	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton.....	.14	.12	.18	.18	.16	.21
Broken carton.....	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb
Wire solder, in less than 100 lb., 28c. per lb.; in 100 lb. lots, 26c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package.....	40%
Less than standard package.....	35%